The American Journal of Surgery

EDITED BY

Thurston Scott Welton, M.D., F.A.C.S.

SPECIAL MONOGRAPH

The Surgery of Mediastinal Tumors

By GEORGE J. HEUER
and WILLIAM DEWITT ANDRUS

October 1940

THE AMERICAN JOURNAL OF SURGERY, Inc.
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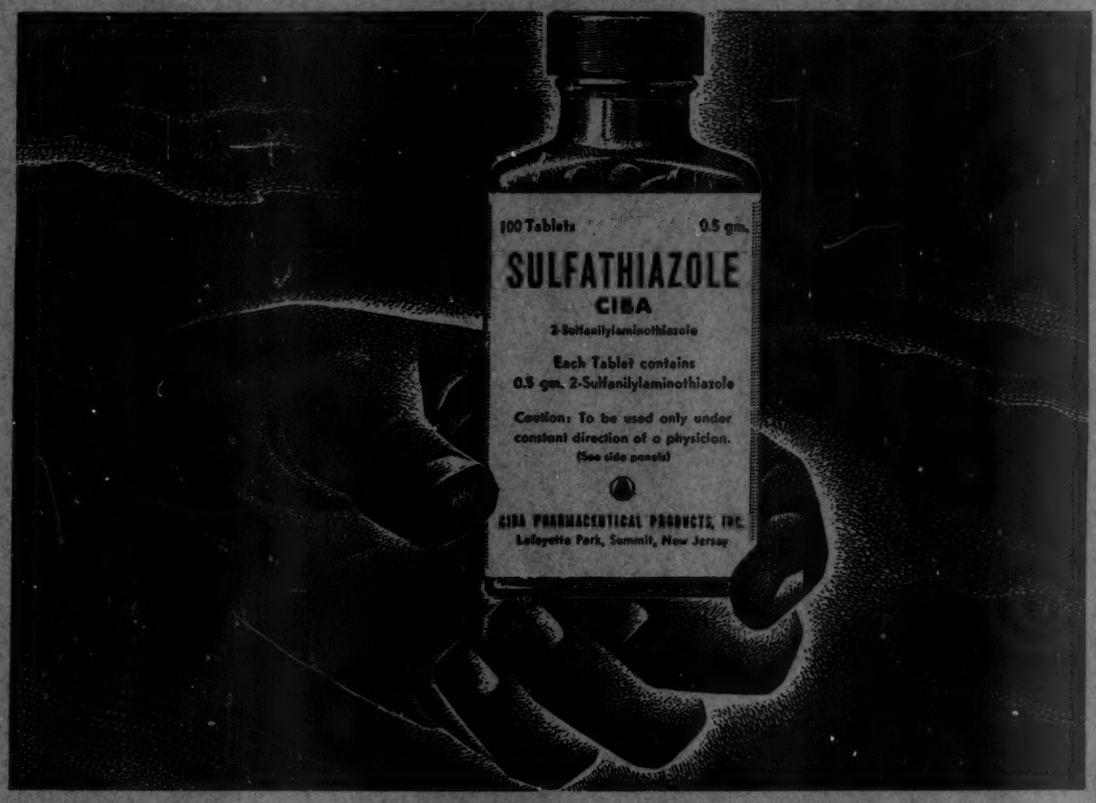

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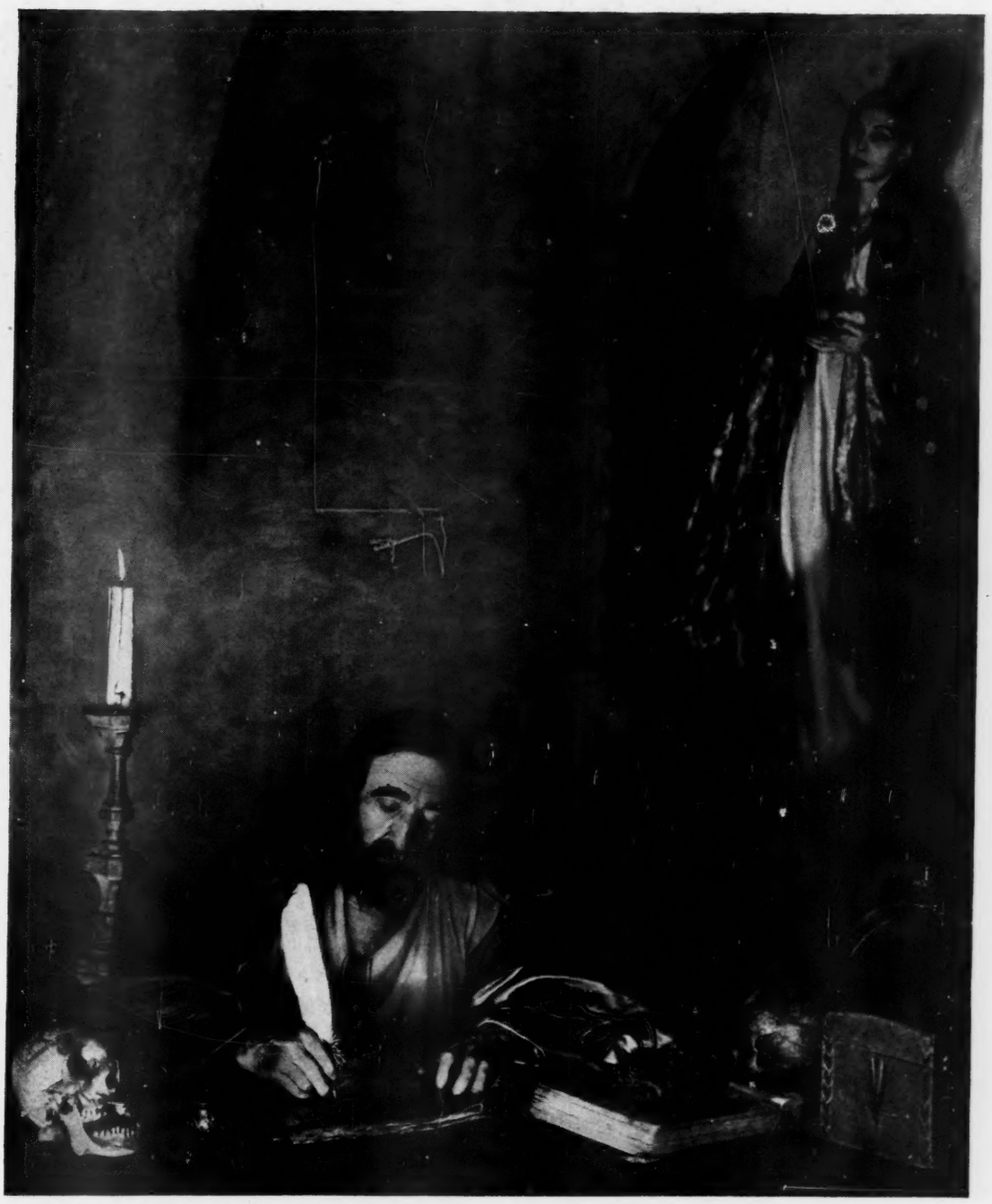
SUTURES IN ANCIENT SURGERY



BRUNO OF CALABRIA whose *Chirurgica Magna* (1252) is notable as the first work to cite both Greek and Arabian writers, also compiled a *Chirurgica Minor* in 23 chapters. In the treatment of large wounds he advises careful suturing with silk or linen, one end of the wound to be left open and sutures to remain for eight days. For abdominal wounds he suggests suturing the peritoneum to the abdominal musculature and emphasizes the advantages of dry healing in all cases.

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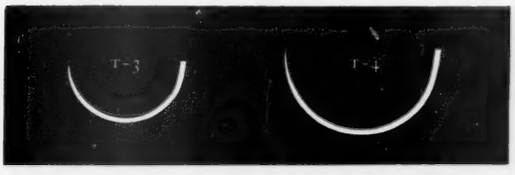

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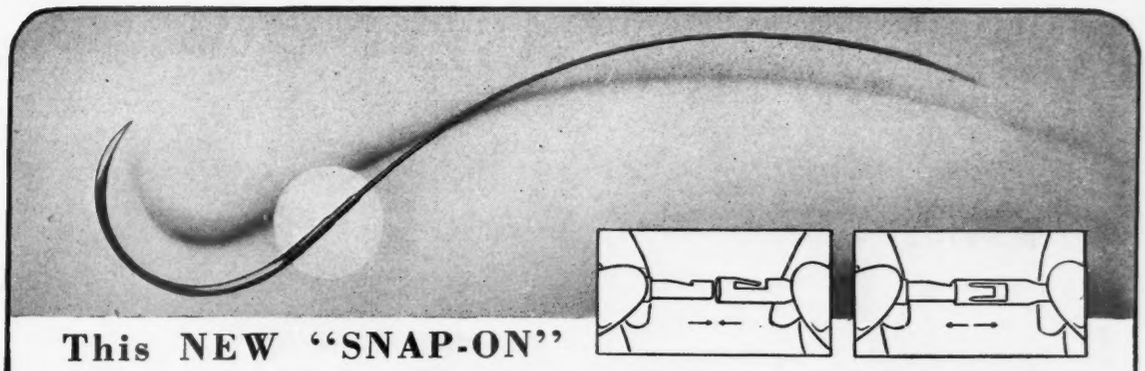

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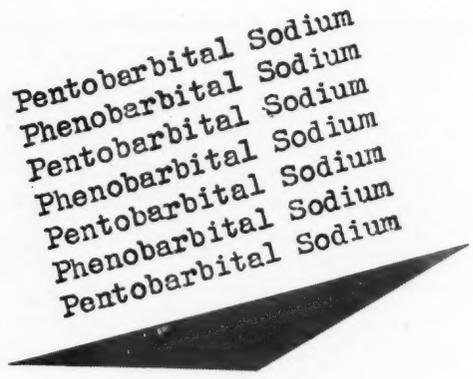

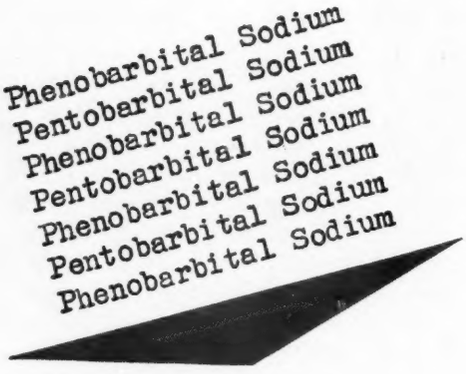

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VIII. Arthrodesing Bone Graft Operations

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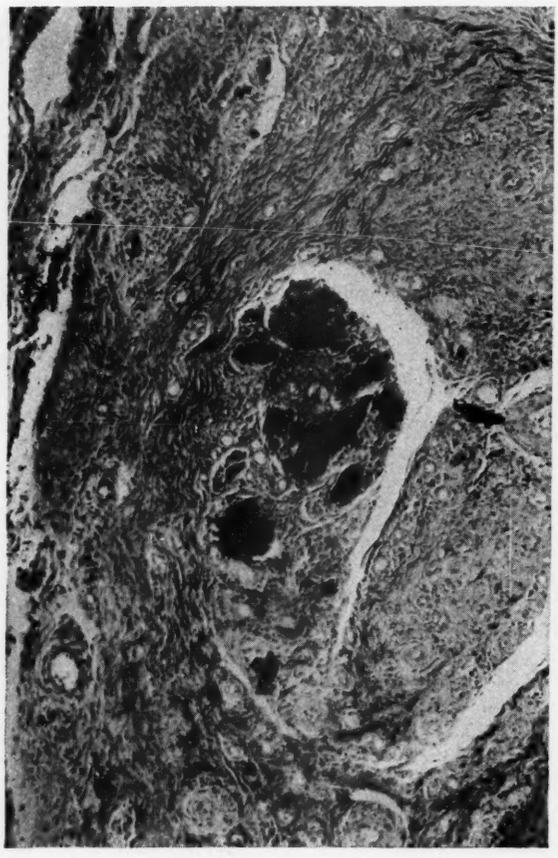
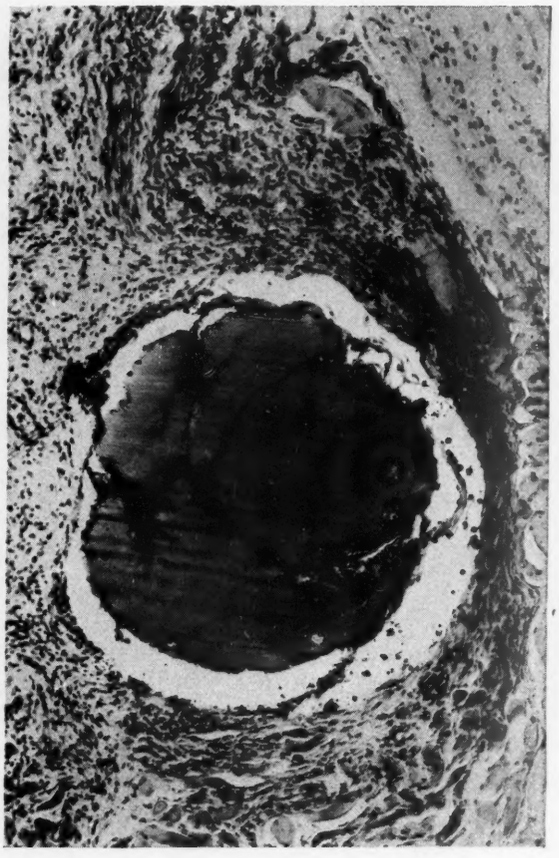


An improperly chromicized strand is almost completely absorbed.



This photomicrograph of normal absorption at 14 days is evidence of correct chromicizing.

Different chemical combinations of chromium and collagen (catgut) are possible. The catgut chromicizing process must effect a *correct* chemical combination if the strand is to have reliable absorption characteristics.

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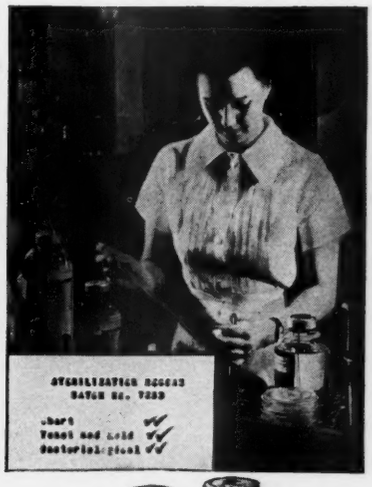

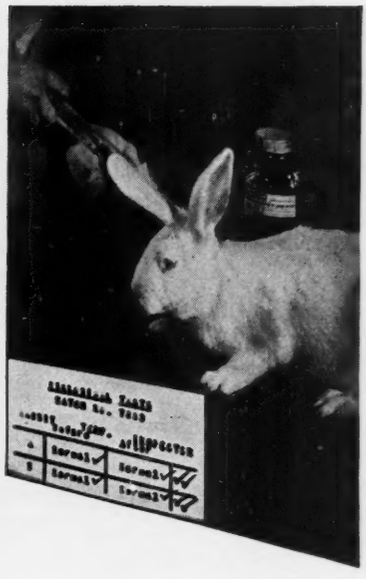

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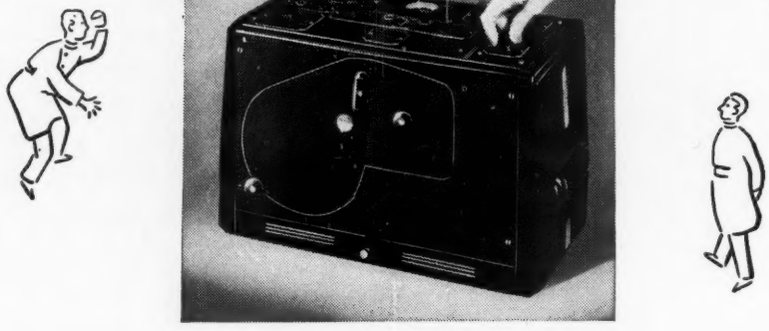

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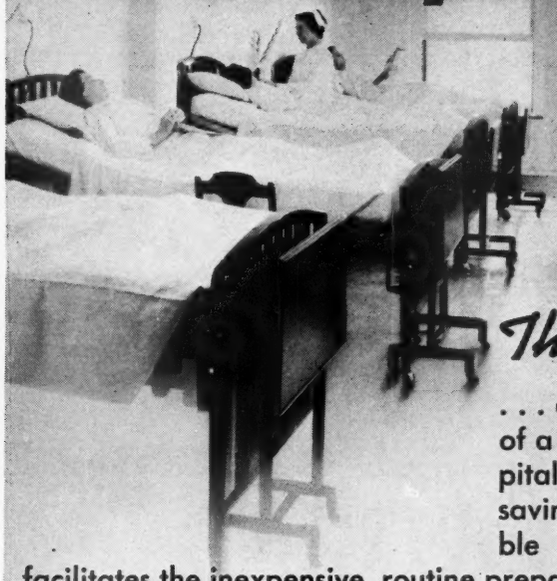

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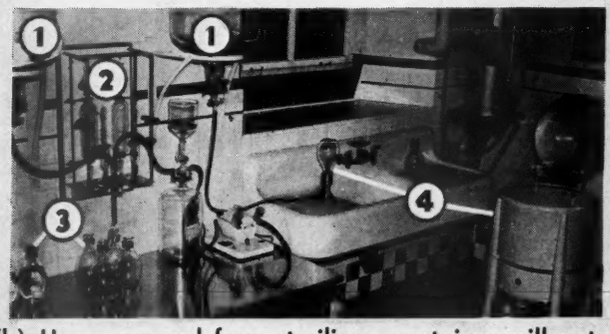

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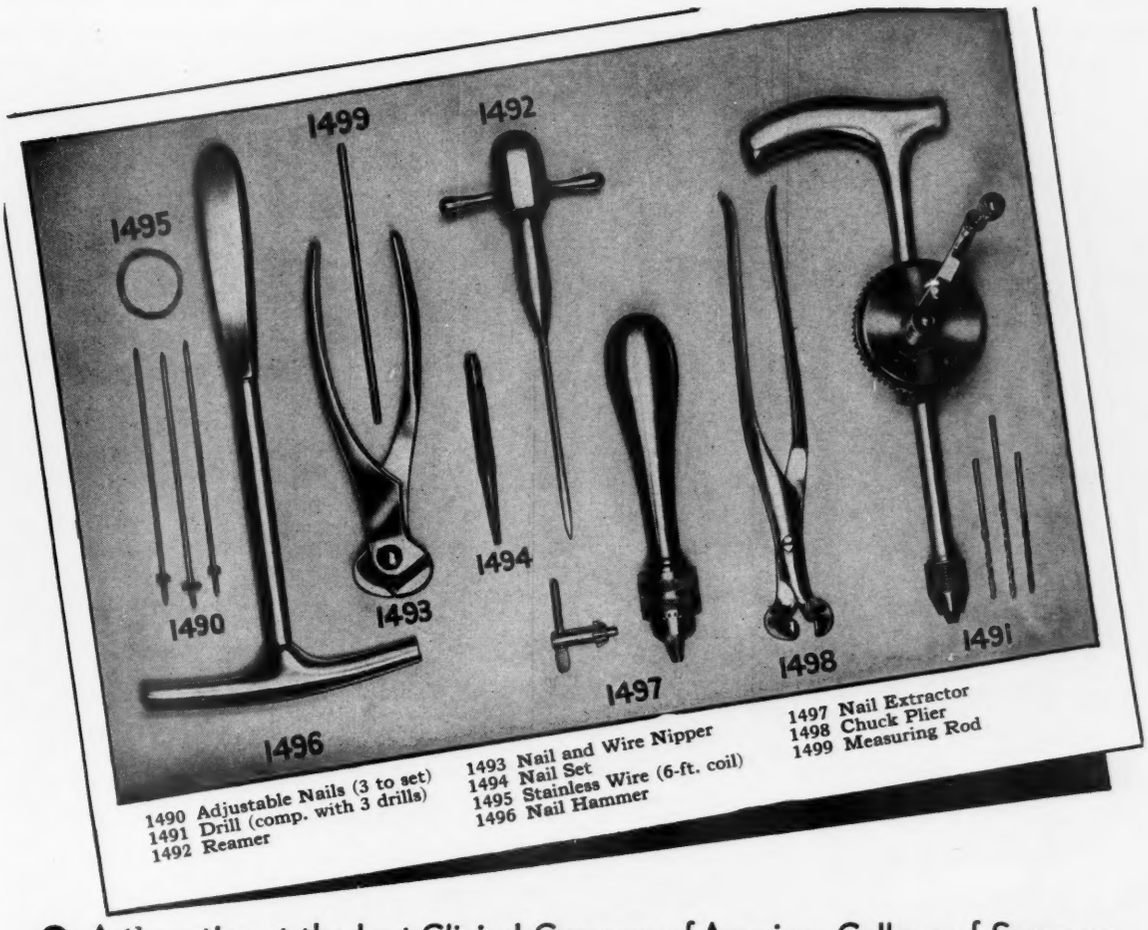

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Send for reprint of an article by Dr. Moore on "Fracture of the Hip Joint" from Surgery, Gynecology & Obstetrics, Vol. 64, No. 2A, Feb. 15, 1937.

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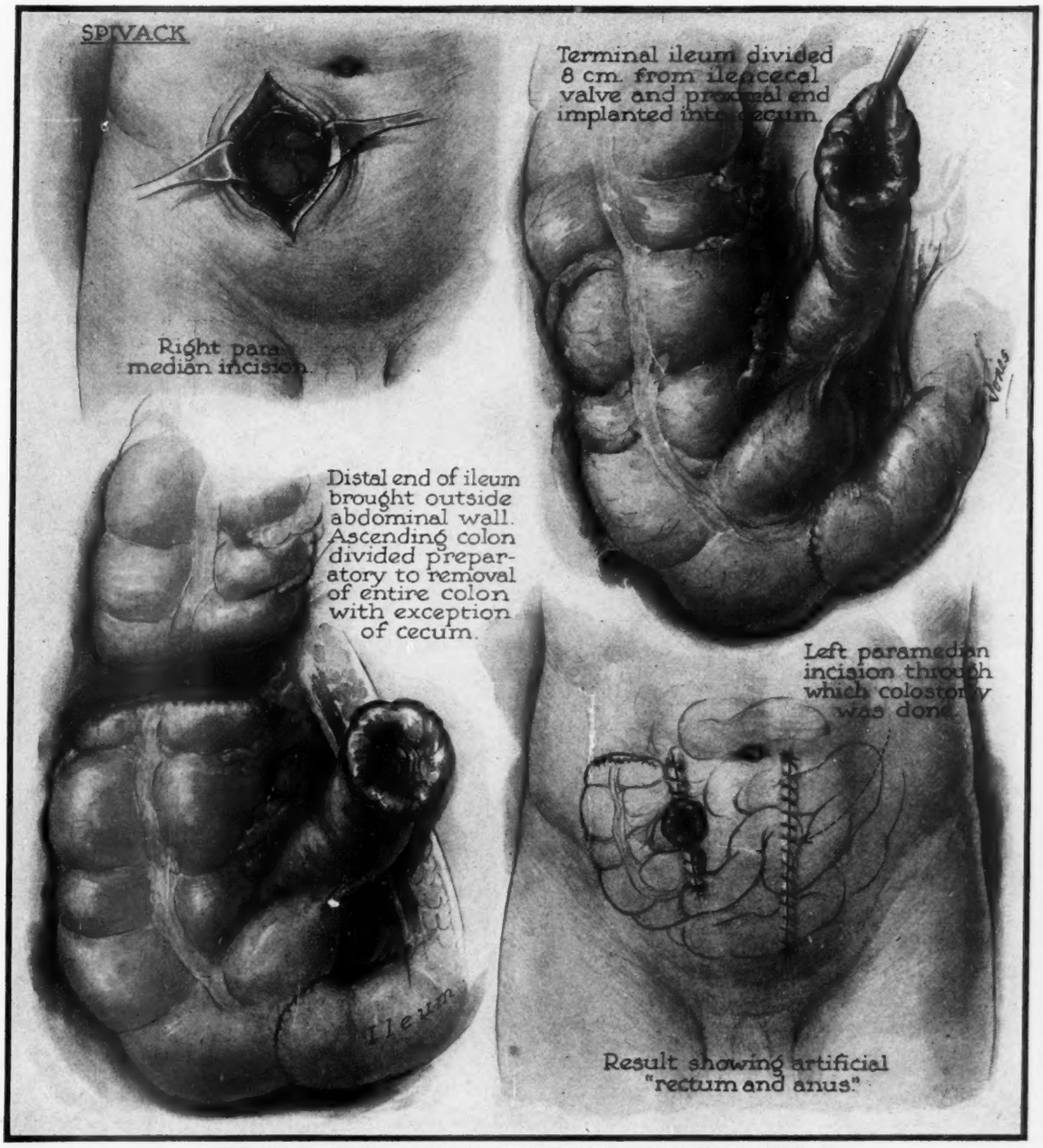
SPIVACK
Right paramedian incision.
Terminal ileum divided 8 cm. from ileocecal valve and proximal end implanted into cecum.
Distal end of ileum brought outside abdominal wall. Ascending colon divided preparatory to removal of entire colon with exception of cecum.
Ileum
Left paramedian incision through which colostomy was done.
Result showing artificial "rectum and anus."

OPERATIVE PROCEDURE—PLATE NO. 110—COPYRIGHT 1940, JOHNSON & JOHNSON

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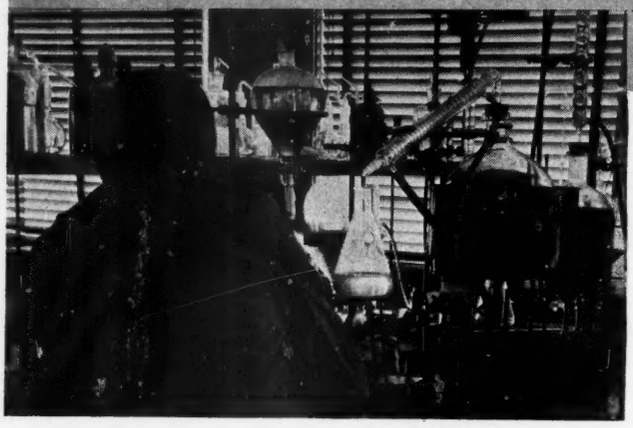

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NEW SERIES, VOL. L OCTOBER, 1940 NO. 1

The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

EDITORIAL

THREE BOOKS*

BESIDE us as we write are three books that deserve more attention than is possible in the usual professional review. In fact, this is no attempt to do other than tell you how unusual and good these books are. One of them is the autobiography of a master surgeon, an acknowledged pioneer in his specialty; another is a volume dated June 1, 1940, a birthday tribute to a master craftsman and surgical pioneer; the last is an autobiography, slightly camouflaged by its writing technic, of a gentleman of parts who also pioneered and reached the heights, and who died just the other day.

Hugh Young—A Surgeon's Autobiography, is the life and work of Hugh Young of Baltimore. In his preface, fearing no doubt that he might be accused of conceit, he tells us how he came to write and have this volume published. When we consider what the author has accomplished in his lifetime, his modesty is refreshing. We read accounts of his vigorous and individual forebears who helped shape his future life. It is lively reading, but all too soon he begins what is really a history of urology in this country and the part he played in it. Inasmuch as he was one of the crusaders and grew up with this branch of medicine, he is just the man to leave this history to posterity. In the frontispiece is a reproduction of a painting of Dr. Young by Sir William Orpen, and William P. Didusch has contributed over a hundred drawings. It is a delightfully written book and one that is sure to fascinate physicians and surgeons and especially urologists.

It is now the fashion to honor one in the flesh and not wait for postmortem memorials. This is fitting and as it should be. The background of one who has earned a position in high places and who has won the esteem of his fellow workers is often a story of hard work and backbreaking, drab labor. Therefore, it is little enough on a special occasion for his friends to gather round him and give a cheer. This happened to Frank Howard Lahey of Boston on the occasion of his sixtieth birthday. His medical and lay friends on this occasion tendered him a Birthday Volume which was an apt tribute and a gracious gesture. Over fifty physicians and scientists whose names are bywords in the world of science and medicine have contributed forty-nine technical or scientific articles. Walter C. Alvarez contributed, "Congratulations to Dr. Frank Lahey," and the book ends with "An Appraisal" by Arthur W. Booth.

* Hugh Young—A Surgeon's Autobiography. Harcourt, Brace and Company, 1940.
Frank Howard Lahey—Birthday Volume. Charles C. Thomas, 1940.
As I Remember Him—The Biography of R. S. By Hans Zinsser. Little, Brown and Company, 1940.

Once in your hands you will read it from cover to cover. Typographically it is a beautiful book and something lovely to look at; it is a work that is certain to stand out in the medical literature for a long time to come; and it was a fitting offering to a surgeon who in the early autumn of his career has meant so much to surgery as a master craftsman, inventor, teacher and author.

About a week ago (September 4, 1940) we bought Hans Zinsser's book (it was not sent to us for review) and that day began to read it; on that same day we read of the author's death. We have now put "As I Remember Him—The Biography of R. S." on our night table so that we can pick it up before sleep and reread many parts. We enjoyed Zinsser's "Rats, Lice and History," but this informal and unusual biography of R. S.—who is none other than the author—is truly a classic. In this estimate of his work the majority of the professional reviewers have agreed without a dissenting opinion. As most of us know, Zinsser was a man of many accomplishments; he was a poet, a lover of the classics, he acquired a broad culture, was a philosopher of no mean degree and a linguist, and as a bacteriologist was known the world over. His work on typhus, alone, earned for him a permanent place in medical history. His sense of humor and of the ridiculous was broad and keen. He was interested in so many things; he dipped his fingers into so many places; he knew and lived with all kinds of people; he never sidestepped an argument. He was a positive fellow, although in his writing he tells us that often he was in the wrong. A profound student, a true friend, he knew his days were numbered, that the end would overtake him swiftly (he had leukemia), and the part of his book in which he tells us of his philosophy in the ebbing time of his life is a moving recital. He does not resort to cheap tricks of writing. He does not pity himself nor seek the sympathy of the reader. These pages are stirring and beautiful and will be read and reread many times. It is not often that such a book appears; in the language of the man of the streets, "it has everything." In many portions of the book the reader will pause and see himself when a young man early in his medical career; at other parts he will stop reading, close his eyes and slowly digest what he has read—and then dream. You'll find this book, by one of us who died too soon, a work you'll want to own, and after you have read the last line you will wish it was many times longer.

These three books, two written by figures that loom large on the medical canvas, and one a birthday volume, a tribute to a man who has been a surgical pioneer and a leader in the ranks of organized medicine, might well grace the shelves of historical medicine for now and the years to come.

T. S. W.

ORIGINAL ARTICLES

RUPTURE OF THE QUADRICEPS TENDON*

WITH A REPORT OF THREE CASES

FRANCIS M. CONWAY, M.D., F.A.C.S.

Assistant Attending Surgeon and Chief of Surgical Clinic, St. Vincent's Hospital

NEW YORK, NEW YORK

INTRODUCTION

THE function of leg extension is accomplished by a muscle and tendon ensemble composed of the rectus femoris and the three vasti muscles, the tendons of which converge in their inferior portion to be united into one common tendon, the *quadriceps tendon*. This tendon, partially interrupted in its course by a large sesamoid bone, the patella, is inserted in the anterior tuberosity of the tibia. It has seemed timely to review the types of quadriceps tendon injury and herewith are reported three varieties of this injury.

HISTORICAL

The first recorded mention of quadriceps tendon injury is in the writings of Galen, who stated that "during a wrestling match, the patellar ligament was broken, and after healing, the patient, who was a young man, could not flex the knee nor walk on an inclined plane without risk of falling."

Following Ruysch's paper in 1720, J. Louis Petit reported three cases in 1723. Schlichting (1742), Molinelli (1767), Sedillot (1786), Saucerotte (1801), Dupuytren (1816 and 1817), and Vanderlinden (1834), all reported individual observations on this theme. In England, Samuel (1838) is the first to record a case of rupture of the quadriceps tendon in the English literature. Continued mention of the condition was made by the French observers Demarquay (1842), Boyer (1845), and Binet (1858).

A capital fact which dominated the history of this condition as well as the treatment, was the advent of asepsis, for up to 1878 when Lister practiced suture of the tendon under antisepsis for the first time, the treatment had been purely medical, by means of packs, poultices and immobilization of the extremity. Maydl's article (1883) is an elaborate study of this injury in connection with fractures of the patella and rupture of its ligament, all the cases being treated without operation. E. Blanc (1887) in reporting a ruptured quadriceps tendon case, again advocated the nonoperative treatment.

It is of more than passing interest to note that the first successful operative result in the United States was reported by Charles McBurney of New York in 1887. He had operated on a 50 year old male in 1885 for a ruptured quadriceps tendon which he sutured with catgut and silver wire. Bull (1889), after reviewing the literature up to this time, reports an operative case of his own with successful outcome and in addition, records the first four reported operated cases of suture of the quadriceps tendon. These were McBurney's (1885), Lüning's (1880), Wilkin's (1887), Hartley's (1888).

To Poirier (1899) we are indebted for a most meticulous anatomopathologic description of the muscle planes comprising the quadriceps extensor apparatus as well as for a more complete understanding of the variations in the different clinical types.

* From the Second Surgical Division, St. Vincent's Hospital, New York City, Dr. R. P. Sullivan, Director.

Quenu and Duval (1905) review a series of twenty-one operative cases and detail the necessity and methods of surgical treatment. Their results were creditable.

Ombrédanne, in 1906, made a series of anatomic studies on the cadaver to outline the causation of this injury. McMaster (1933) experimented on rabbits, producing tendon and muscle ruptures. Of the more recent reports of cases, the following: Ottolenghi and Pique (1935), Austoni (1936), Lenormant and Olivier (1933), Clapp (1921), Gabilland (1929–1930), Guillaume-Louis (1928), Delbet (1924), Jeanneney (1929), Quilichini (1932), Guilemen (1928), Vanlande (1928), Michel (1928), Sejournet (1927), Bolognesi (1931), Brun (1933) and Gilcreest (1933) have all contributed appreciably to our present day concept of the problem.

ETIOLOGY

Occurrence. Despite some reports, it is our experience that rupture of the quadriceps tendon is a rather infrequent catastrophe. For the past five years, there have been only five cases treated at St. Vincent's Hospital. This is a rather striking fact in view of the situation of the institution in a busy metropolis and its proximity to industry. Only three cases required surgical intervention as the other two were incomplete muscular tears.

As compared to the total causes of disruption of the extensor apparatus of the leg, ruptures of the quadriceps tendon form but a small percentage. Clap[16] reports this incidence in a series of seventy cases from the service of Professor Delbet. (Table I.)

TABLE I

	Cases	Percentage
1. Fractures of the patella	62	88.5
2. Rupture of patellar ligament	4	5.7
3. Rupture of quadriceps tendon	3	4.2
4. Rupture of tendon with the tearing away of the tibial tuberosity	1	1.4

The majority of all cases have been in men between the ages of 30 and 50 years of age and many observers believe that the ruptures occur in muscles and tendons predisposed to their production. The occurrence in the young is exceptionally infrequent, and although Potherot reports a case in a child of 5 years, the condition is rare before 20.

Causes. Many authors have postulated predisposing and local causes for the occurrence of this injury. (Table II.)

TABLE II

Predisposing causes	1. Metabolic disorders	gout, diabetes, arteriosclerosis, obesity
	2. Lues	
	3. Chronic nephritis	
	4. Old poliomyelitis	
	5. Chronic osteoarthritis	
	6. Acute infectious diseases as typhoid, etc.	
	7. Trichiniasis	
	8. Unusually heavy labor	
	9. Congenital defects	fragilitas ossium, osteopsathyrosis
Local causes	1. Ankylosis of knee joint	
	2. Hydroarthrosis	
	3. Periarticular lesions of chronic arthritis	
	4. Muscle degenerations	
	5. Calcareous infiltration of tendinous insertions	
	6. Trauma	direct, indirect

Lenormant and Olivier believe that a great number of cases of rupture are prepared for by modifications in the structure of the patella itself.

Determining or Immediate Inducing Causes. Sometimes the actual inducing cause is apparently slight—a physiologic act such as walking, ascending or descending a flight of stairs, movements made on turning around. Certain observers even speak of "spontaneous ruptures." McMaster's studies on animals and the clinical observations derived therefrom are of intense interest in this respect:

1. Normal tendon did not rupture when subjected to severe strain. Either the tendon insertion pulled away; the muscle belly ruptured; the musculotendinous junction separated; the muscle origin pulled out; or fracture of the bones occurred. The tendon or muscle, in pulling away from either insertion or origin, detached a small fragment of bone.

2. Approximately one-half of a tendon's fibers had to be severed to permit of immediate rupture when subjected to severe strain. Spontaneous rupture did not occur following severance of approximately three-fourths of a tendon's fibers under ordinary activity.

3. Obstruction to the blood supply of 1 cm. of a normal tendon by double ligation caused rupture in this obstructed area as early as four weeks afterwards, when it was subjected to strain, even though the tendon sheath had been carefully replaced.

4. The blood supply of a tendon was more important in the separative processes of injured tendons than the presence of the tendon sheath.

McMaster's clinical conclusions, based on his experimental animal studies, were that when a normal muscle-tendon system is subjected to severe strain, the tendon does not rupture. However, rupture may occur (1) at the insertion of the tendon to bone; (2) at the musculotendinous junction; (3) through the belly of the muscle; and (4) at the origin of the muscle from the bone. Either the muscle or the tendon may pull away a small fragment of bone, and sometimes the strain results in fracture or dislocation. Disease processes in tendons predispose to their "*spontaneous rupture*" often from only slight strain as in tendons affected by (1) tuberculous tenosynovitis, (2) gonococcal tenovaginitis, and (3) trichiniasis, typhoid, lues, or tumors. Rupture of muscle fibers occurs following both direct and indirect types of trauma. Degenerative changes and disease processes in muscles predispose to their rupture. Minimal to more extensive muscle ruptures occur following varying degrees of direct or indirect trauma and are often overlooked in clinical cases.

Quilichini indicates that "almost all the traumatic ruptures of the quadriceps due to *indirect* violence occur as a result of pure muscular contraction following such forced muscular movements as are employed in the effort to avoid an impending, oncoming or imminent fall." These are produced almost exclusively in men who are vigorous and who are engaged in either muscular tasks or very active work. The ruptures due to *indirect* violence are less frequent, but nevertheless have an equally important etiology. Spontaneous ruptures are extremely rare. The factors producing them are the same as those which produce similar ruptures in other muscles. General diatheses as the causes were found by Hofeman in two cases due to tabes; by Chavannez in one case due to tuberculosis and rheumatism; by Ritter in one case due to old lues; by Frankenthall in a case due to diabetes; by Maydl and Vulpius in cases due to local degenerative affections; and by Kalliebe in a case due to fatty infiltration of muscle.

Ordinarily, the muscular contraction is very violent and usually a misstep or an attempt to regain one's balance is made following an effort to avoid a fall. This produces a rupture of the extensor apparatus and the fall then occurs actually as a result of the rupture. Of Bull's five operative cases reported in 1889, three were the result of direct blows or lacerating assaults, and two were the result of indirect violence. Binet reports that in twenty-four cases the rupture of the quadriceps tendon occurred fourteen times after an effort to avoid a fall. Sellier, in reporting twenty-seven cases of patellar ligament rupture where the cause of rupture was indicated, states that fifteen were due to a misstep in an attempt to avoid a fall; eleven were due to a fall with the leg flexed on the thigh; and one was due to spontaneous rupture in the course of walking or marching. Ombrédanne (1906), in his experiences with the cadaver, demonstrated in his effort to produce rupture of the quadriceps tendon by direct violence that when the leg was in extension and the patella naturally in a state of relaxation, rupture of the tendon in either its suprapatellar or infrapatellar portions was impossible. In addition, he concluded that muscular contraction was at the basis of all ruptures by indirect violence. Usually by making an effort to resist an obstacle

the patient breaks his tendon by indirect violence.

Sellier, in twenty-one cases, found the tendon ruptured at the superior patellar insertion in six cases; at the superior patellar insertion with bone lesion in one case; at the midportion of the patellar tendon in three cases; at the inferior patellar margin in nine cases; and at the tibial insertion in two cases.

TABLE III

CLINICAL VARIETIES OF RUPTURE

- I. Suprapatellar ruptures
  - A. Pure muscular
    - fibrillar tears
    - partial rupture
    - laceration
  - B. Musculotendinous
    - with joint involvement
    - without joint involvement
  - C. Tendinous tears
    - at junction of muscle
      - with joint involvement
      - without joint involvement
    - at midpoint of tendon
    - at patellar attachment
      - without bone detachment
      - with bone detachment
- II. Infrapatellar ruptures
  - A. At the inferior border of patella
    - with bone injury
    - without bone injury
  - B. At midportion of patellar ligament
  - C. At insertion of quadriceps tendon
    - without tibial bone damage
    - with tearing away of anterior tibial tuberosity

PATHOLOGIC ANATOMY

The anatomic structure of the extensor apparatus explains the varieties of ruptures encountered. Four muscles form the quadriceps femoris—these are the rectus femoris and the three vasti muscles, *lateralis*, *medialis*, and *intermedius* or *crureus*. These muscles are distinctive in that they unite in the formation of one common tendon and that they have the largest sesamoid bone in the body incorporated in this tendon.

To Poirier we are indebted for the first concise description of the surgical anatomy of the quadriceps extensor apparatus. The inferior insertion of the quadriceps femoris is very complex and the several parts which comprise it do not rupture, as a rule, at the same time. As was pointed out, the tendinous insertion is composed of three planes. The planes are: (1) a *superficial* or *anterior* plane containing the *rectus* femoris; (2) a *second* or *middle* plane comprising the *vastus lateralis* and vastus medialis; and (3) the *third* or *posterior* plane consisting of the *vastus intermedius* or *crureus* muscle and containing little of the tendinous parts. (Figs. 1 and 2.) If the superficial plane tears at the level of the patellar insertion, then the *middle plane* tears at a higher level. When the *third* or *posterior* plane tears, it is generally at a still higher level than the other two planes and in an irregular manner.

When the vastus intermedius or crureus muscle is lacerated, the quadriceps *cul-de-sac* or pouch is torn and the synovium is involved in the rupture. The hemathrosis present in this type of rupture is due invariably to this tear of the synovium at the base of the quadriceps bursa. From this it may be seen that ruptures of the quadriceps extensor apparatus may be partial or complete. If complete they are tears throughout the entire three planes. Partial ruptures are usually in the rectus femoris only.

The principal tendinous portion of the apparatus is the quadriceps tendon which is fixed into the anterior tibial tuberosity. It is interrupted in its course by the large sesamoid. This bone divides the tendon into the suprapatellar portion and the infrapatellar portion, also known as the patellar or tibiopatellar ligament.

Now the *superficial* or *anterior plane* consists of the rectus femoris and the most anterior fibers are only slightly adherent to the patella. They proceed without interruption to the insertion at the tibial

tubercle. But the greater part of the fibers are fixed into the base of the patella in its *anterior edge* and to the *anterior face* along the *superior edge.*

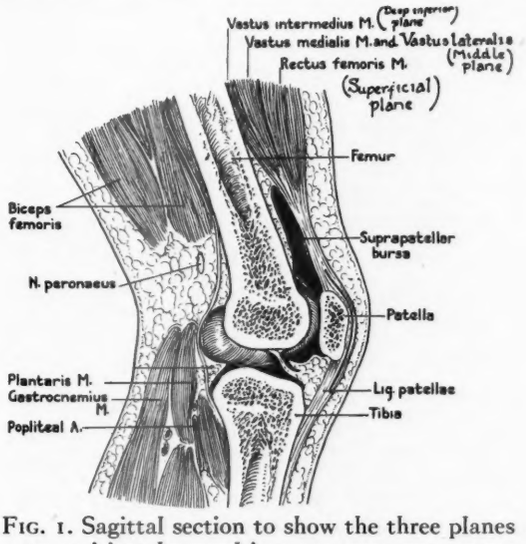

FIG. 1. Sagittal section to show the three planes comprising the quadriceps extensor apparatus. (1) The *superficial* or *anterior plane* formed by the rectus femoris muscle. (2) The *middle plane* formed by the decussating fibers of the vastus medialis and vastus lateralis muscles. (3) The *deep* or *posterior plane* made up by the vastus intermedius or crureus muscle.

The tendons of the vastus medialis and vastus lateralis united with each other on the inferior segment constitute the *middle plane* immediately behind the insertion of the rectus femoris, in such a way that their lowermost fibers come to end along the lateral edges of the patella.

Finally, the tendon of the vastus intermedius or crureus is fixed into the patella below the insertions of the vastus medialis and vastus lateralis and constitutes the deep plane of the quadriceps tendon. These various planes differ from each other in the direction of their fibers. The fibers of the tendon of the *rectus femoris* and the *crureus* (vastus intermedius) run parallel to the long axis of the quadriceps whereas the fibers of the vastus lateralis and vastus medialis converge towards each other and form a tendinous V at the point where they become affixed to the patella.

The infrapatellar portion of the quadriceps tendon, called the patellar ligament, extends from the apex of the patella to the anterior tibial tuberosity. The superficial aspect of this portion is covered by the arciform fibers. A certain number of the quadriceps fibers do not attach directly or

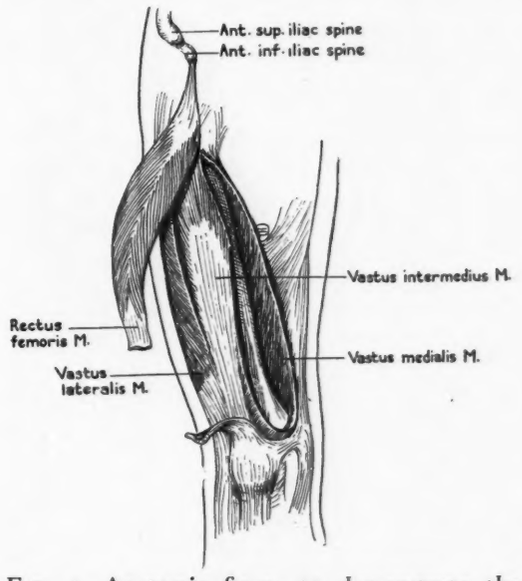

FIG. 2. Anatomic figure to demonstrate the three planes which comprise the quadriceps tendon in its suprapatellar position. The deep plane of the vastus intermedius is shown as well as the middle plane of the decussating fibers of the lateral and medial vastus muscles. The superficial plane of the rectus femoris has been turned out in order to show the deeper structures.

indirectly to the anterior tibial eminence. This is of clinical importance, for it determines whether function loss will be partial or complete, depending on whether or not these fibers are ruptured.

The lateral and medial vasti muscles send fibers insert into the lateral and medial aspect of the tibial condyles. The ruptures of the quadriceps tendon occupy two regions: (1) the *suprapatellar* region between the patella and the muscular portion of the *quadriceps femoris;* and (2) the *infrapatellar* region between the patella and the anterior tibial tuberosity. Of the tendinous ruptures, the quadriceps ruptures can occur on two sides. The more frequent condition is to have the rupture unilateral, and in the great majority of cases this occurs in the vicinity of the point of the patellar insertion. In twenty-one cases, Berger found the point of rupture to be

fourteen times at the superior border of the patella, twice 2 cm. above this point, and five times 4–5 cm. higher. In some cases, as that of Poirier for example, the quadriceps and its fascia broke at different points; i.e., the tendon of the rectus femoris 4 mm. above the patella and the tendon of the vastus intermedius or crureus at 8 cm. above the patella. These ruptures may be limited to the rectus femoris entirely, or they may continue to include the vasti muscles which give rise to the lateral patellar aponeurotic expansions. When ruptures extend to the deeper planes, synovial lining becomes involved and the large hemarthroses are explained.

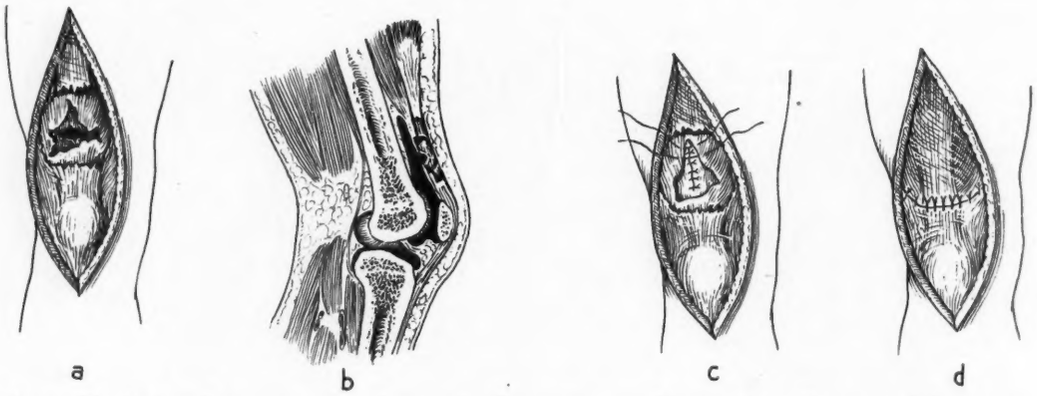

FIG. 3. Typical and common type of suprapatellar rupture and its repair. *a*, Rupture of the suprapatellar type revealing the extension of the rupture into the synovium with the attendant hemarthrosis. The quadriceps bursa has been torn. *b*, Sagittal view of the rupture disclosing the usual clinical findings with involvement of the three planes. It is to be noted that the planes are divided at different levels. The middle plane is divided at a higher level than the superficial plane. The deep plane is ruptured at a still higher level. *c*, The first stage in the operative repair discloses the synovium and the fibers of the vastus intermedius to have been brought together. This establishes the deep plane. In addition, two sutures have been placed in the torn ends of the decussating fibers of the vastus medialis and vastus lateralis in order to restore the middle plane. *d*, The final stage in the closure has brought the torn ends of the rectus femoris together with interrupted sutures. Several other sutures have been placed in the circumarthroidal tissues.

SYMPTOMATOLOGY

In describing the symptoms and signs encountered in the various types of rupture and in the varying degrees of ligamentous tear, one must first consider whether the lesion is a recent or an old injury. The signs and symptoms which are attendant upon this condition depend entirely on (1) the time and manner of occurrence of the accident; (2) the degree of separation of the fragment; (3) the extent of the laceration of the underlying structures. Our attention is to be focused first on the symptoms and signs occurring with fresh or recent injuries.

The trilogy of symptoms of rupture of the quadriceps tendon at the moment of the fall are *pain, crepitus* and *function loss:*

- **Pain**
  - Is violent and immediate.
  - Is compared to a sudden contraction of the muscles of the leg.
  - Decreases with immobilization of the leg.
  - Reappears and increases with any movement of the leg.
- **Crepitus**
  - Is not necessarily a constant accompaniment.
  - Is due to the sanguinous effusion which will be confounded after with crepitus due to fracture.
- **Function loss**
  - Power to extend the leg has gone.
  - Walking on the plane surface is impossible. If walking is still possible, the high rupture of the tendon has not reached or entirely cut through the vasti muscles which relatively will supply some of the tendon deficiency.

Examination of the extremity shows us the leg half flexed on the thigh. It is the position of rest for the joint and the sign of intra-articular involvement. It is likewise due to the tonicity and muscle spasm of the opposing group on the posterior aspect of the thigh no longer being compensated

by the pull of the quadriceps group. Somewhat rarely, as in our third case, there is ecchymosis at the point of contact where the injury is due to direct violence. (Fig. 5.) Hemarthrosis and the infiltration of the loose cellular tissue of the subcutaneous regions account for the swelling.

The pathognomonic physical sign of a suprapatellar rupture of the quadriceps tendon is the absence of the fullness due to the quadriceps pouch. This concavity or depression varies in depth with the extent of the rupture. It is only slightly marked if the anterior portion of the rectus femoris alone is torn. With an extensive laceration of the lateral expansions of the vasti muscles, one can visualize the superior aspect of the femoral condyles. The pathognomonic sign of complete infrapatellar ruptures is the shift upward of the patella. Hemarthrosis of the knee joint will *per se* indicate an injury extensive in type, for it has already involved the synovial lining of the joint cavity. *X*-ray of the knee joint and the anterior tibial tuberosity will demonstrate the degree of bone damage in those cases of infrapatellar damage with bone involvement, as in Case III. The differential diagnosis seldom becomes a problem of any great moment. From patellar fractures which might produce many similar clinical phenomena, the radiograph will clearly define the nature of the injury. Similarly, dislocations of the knee joint and other traumatic intra-articular derangements may be excluded.

In *old* cases where disability has existed for a long time, the symptoms and signs are again dependent upon the type of rupture and the extent of the accompanying tissue damage. There is inability to extend the knee, with consequent decrease in power to climb any incline and lack of stability in ordinary walking on a level plane. This disability will vary in degree depending on the extent of muscle and tendon retraction and the involvement of the surrounding structures. The degree of quadriceps atrophy will also be a factor.

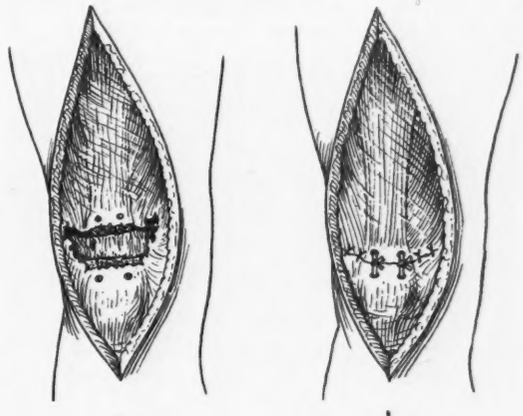

Fig. 4. Variation of the suprapatellar type of rupture. When rupture has also torn a fragment of the patella, the repair requires additional secure fixation. *a*, Demonstration of suprapatellar tearing with bone involvement. *b*, Repair of the bone defect by fixation to the corpus of the patella.

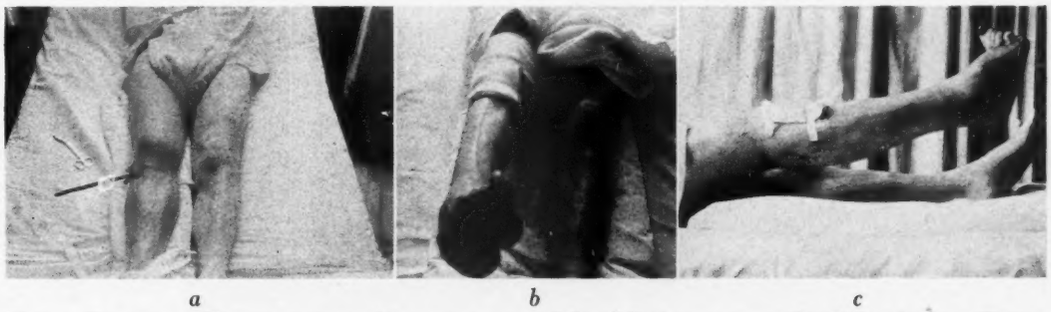

Fig. 5. Case III. *a*, Shows preoperative appearance of the right lower extremity July 18, 1939. Power of extension is absent. The knee joint is swollen and ecchymotic and the normal markings are absent. Comparison with the unaffected extremity reveals the marked difference in the external configuration. The arrow indicates the local hematoma caused by the direct blow to the tibial tuberosity. *b* and *c*, Reveal the postoperative appearance with the patient being able to extend the leg. The old deformity of the foot is also shown. (Photograph taken September, 1939.)

TREATMENT

The treatment involved in the repair of the extensor apparatus is divided into two main groups:

I. Treatment of recent injuries
   (*a*) Nonoperative immobilization.
   (*b*) Operative treatment.
II. Treatment of late or old injuries
   (*a*) Those cases which have not had previous operative interference.
   (*b*) Those cases subsequent to previous operative repair.

The two fundamental objectives of all the technical procedures are first, the apposition of the ruptured parts and secondly, the prevention of quadriceps muscle atrophy. All operations are preceded by the usual forty-eight hour skin preparation routine to all open extremity procedures.

Today the only cases regarded as *nonoperative* entities are those incomplete musculotendinous or fibrillotendinous ruptures where function is good in spite of the injury. Even in these cases, unless some general contraindication exists, the operative repair offers a quicker, more certain and more complete end result. Motion may be started earlier and the possibility of quadriceps atrophy is reduced to a minimum.

For comparison, it will be of interest to review the treatment of the operative cases reported by Bull in 1889.

While it may seem trite to repeat that the successful operative treatment of quadriceps ruptures depends solely upon anatomic reposition of the component parts, an appreciation of this fact may be gleaned from the surgical anatomy of the area involved. For this reason no didactic out-

TABLE IV

No.	Reporter	Sex and Age	Date	Manner of Injury	Treatment	Results
1	McBurney. *Ann. Surg.*, 6: 170, 1887.	Male 50	1885	Rupture near insertion into right tibia. Direct blow.	Suture of tendon with catgut. Retention suture of wire into tibia.	At eleventh week walked with cane. One year later, function perfect.
2	Lüning. *Corr. f. schweiz. aerzte*, 2: 689, 1881.	Male 18	1880	Tendon cut at insertion into patella. Butcher's chopper cut leg.	Suture of tendon with catgut.	Fifth month flexion of knee to 120°.
3	Wilkin. *New York J. Med.*, 28: 378, 1887.	Male 7	1887	Incised wound of thigh with cut tendon and an opening into joint.	Suture of tendon with silkworm gut.	At end of third month, flexion almost perfect.
4	Hartley. Personal communication.	Male 34	1888	Fall on knee causing suprapatellar rupture with fragment of superior border of patella (½ inch × ¾ inch) contained in ligament.	Suture of tendon with wire fication of patellar fragment and ligament to main portion of patella.	Result poor at end of third month. Very little power of extension.
5	Bull's case. *New York J. Med.*, pp. 421–424, April 20, 1889.	Male 59	1889	Fall on knee flexed with rupture of tendon ¼ inch above insertion into patella.	Suture with four chromic sutures.	Flexion to the right at end of three months. Extension to the horizontal plane.

line of procedure may be postulated but general suggestions only are made.

A. Recent Injuries. 1. *Suprapatellar Rupture.* With the ruptures occurring in the musculotendinous portion (Fig. 1) as well as in that portion of the tendon midway between the superior patellar rim and the muscle, the immediate concern is to determine whether or not the knee joint has been entered. The presence of synovial fluid will, of course, indicate that the *vastus intermedius* or *crureus* which forms the posterior plane has been divided.

Repair begins with the synovial closure followed by the restoration of the interlacing of the decussating fibers from both the lateral and the medial vasti muscles. Subsequently, the tendinous portion of the rectus femoris is brought together. (Fig. 3.)

In that type of suprapatellar rupture which occurs near the superior edge of the patella with or without bone damage, the operator will have to determine for himself whether the case is one suitable for fascial suture plus fixation to the body of the patella. The employment of chromic catgut, silver wire, or kangaroo tendon depends entirely upon the individual operator's preference. The need for careful and secure apposition becomes evident when one considers the tremendous demands made upon this apparatus. (Fig. 4.)

The benefit of direct fixation of the tendon to the body of the patella can be realized when one appreciates the fact that the longitudinal arrangement of the fibers of the tendon permit easy tearing away of simple sutures.

11. *Infrapatellar Rupture.* With the infrapatellar ruptures the problem of securing tendinous fixation is evident. With ruptures involving the inferior patellar rim fascial or heavy catgut fixation plus drilling through the patellar substance appears to be the most satisfactory procedure. Ruptures occurring through the midportion of the tendon are not common, but do occur as in Wagner's case.[101] Avulsion of the most inferior portion of the tendon from the tibial tubercle with or without avulsion of the bone demands direct fixation to the tibia. Case III of the author's falls into this group, and again, the choice of materials is an individual one.

FIG. 6. Radiograph taken July 18, 1939, showing lateral view. The avulsed fragment, *a'-b'*, is shown, having been pulled superiorly from the portion of the tibial crest marked *a-b*.

B. Repair of Delayed and Late Cases. The treatment of delayed or late cases will depend upon whether or not the primary operation has been performed.

To the extent that a weak scar and muscle retraction exist extensor power will be limited. If the scar tissue begins to yield, the disability will increase, with corresponding increase in symptoms until extensor action has ceased. With quadriceps retraction, there is a tearing away of the adjacent circumarthroidal tissues. In this type of case, any attempt to describe didactically any specific type of operative repair is impossible.

The successful treatment of old cases depends upon four main factors: (1) ablation of all old cicatricial tissue; (2) restoration of the continuity of the ten-

don; (3) rehabilitation of the quadriceps muscle; and (4) absence of any intra-articular complications.

are due directly to (1) insufficient treatment, or (2) the local or general individual predisposing causes of the accident.

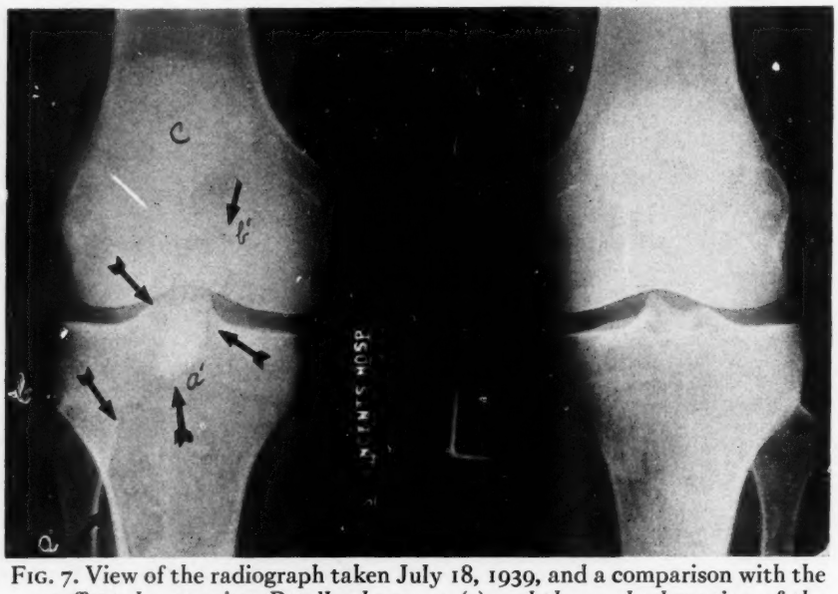

Fig. 7. View of the radiograph taken July 18, 1939, and a comparison with the unaffected extremity. Patella shown at (*c*) and the avulsed portion of the anterior tibial tuberosity, *a'-b'*, is indicated by arrows. The defect in the tibia is armed by *a-b*.

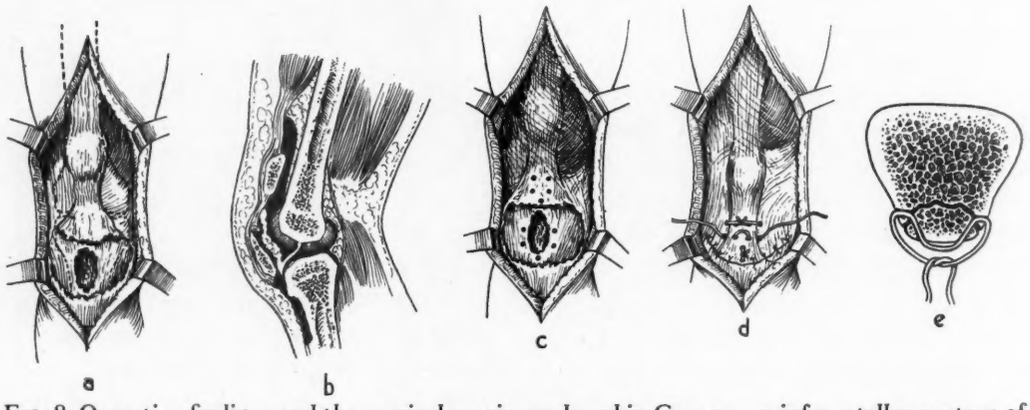

Fig. 8. Operative findings and the surgical repair employed in Case III, an infrapatellar rupture of the quadriceps tendon with avulsion of the tibial tuberosity. *a*, Operative findings showing the avulsed tibial tuberosity and the bed of the tibial crest from which it was torn. The patella is shown retracted superiorly. *b*, Lateral view of the operative findings showing the relative positions of the patella, the avulsed fragment and the portion of the tibia from which it was torn. *c*, First step in the repair of the rupture. The drill holes have been placed in both the avulsed fragment as well as around the portion of the tibia. *d*, The fragment has been replaced and fastened in such a way as to hold it securely. Three points of fixation are noted. In addition the expansions of the tendon are shown sutured with individual chromic sutures. *e*, Manner of placing drill holes and sutures so as to effect a double security of the avulsed fragment.

COMPLICATIONS

The complications encountered in this type of injury may be summarized briefly by stating that apart from the usual well known postoperative catastrophes, they

CASE REPORTS

Case I. A white female, aged 40 years, was admitted to St. Vincent's Hospital December 7, 1935, after she had fallen while crossing the street. The accident was sudden and without

any apparent cause. Her past history was negative; a cholecystectomy had been performed in 1934. Physical examination was also negative except for the local condition of the left lower extremity. There was considerable swelling above and below the patella and an absence of the fullness which is normally due to the presence of the quadriceps bursa. Diagnosis was made of a ruptured quadriceps tendon in its suprapatellar portion.

X-ray examination of the knee showed evidences of soft part swelling above and below the patellar level as well as on the internal aspect of the knee, probably produced by the effusion. No other abnormalities were noted.

Eleven days after admission, following the usual forty-eight hour skin preparation, the tenorrhaphy was performed. At operation the tendon was found ruptured 1½ inches above its insertion into the superior margin of the patella. Considerable old hemorrhagic material was removed. The ruptured ends of the tendon were approximated with five No. 4 chromic sutures and plaster of Paris immobilization was applied.

The postoperative course was uneventful and the patient was discharged with wound healed and function satisfactory on January 10, 1936. After six months her condition was reported as excellent.

Case II. T. D., aged 57 years, white male, was admitted to St. Vincent's Hospital January 30, 1934 following a fall down a staircase in which he had landed on the hyperflexed thigh. Following the accident he could not extend his right leg nor walk, and was brought to the hospital by ambulance. Physical examination was negative except for the local condition of the right lower extremity. The right knee was swollen and ability to raise the foot from the horizontal plane was lost.

X-ray showed considerable joint effusion. A small fragment of the superior aspect of the patella had been pulled upward for a distance of approximately 1 inch from the main body of the patella. Laboratory data were irrelevant except for evidences of coronary sclerosis.

At operation a suprapatellar rupture with a tearing away of some of the cortical surface of the patella was found. Repair was performed with kangaroo tendon and a plaster of Paris case applied.

The postoperative course was complicated by the presence of coronary sclerosis, but the cast was removed on February 15, 1934 and the patient was out of bed two weeks later.

He was discharged in satisfactory condition March 5, 1934 and subsequent followup was favorable.

Case III. C. M., 38 years old, white male, was admitted to the St. Vincent's Hospital on July 15, 1939, two days after an injury to his right knee, stated to have followed a direct blow over the right anterior tibial tuberosity. At the time of admission, there were several other contused areas. The patient was unable to extend his right knee and any attempt to move it caused excruciating pain. There was considerable periarticular swelling and ecchymosis and over the anterior tibial tubercle, a contused area ½ inch square was plainly visible. (Fig. 5A.)

X-ray examination revealed the avulsed fragment of bone attached to the insertion of the ruptured quadriceps tendon. The area from which the bone had been avulsed on the tibial crest was plainly visible. The torn end of the tendon was curled upon itself as were the bony attached fragments. (Figs. 6 and 7.) The patella had shifted upward to a considerable degree.

Repair of the avulsed quadriceps tendon was carried out, with fixation of the anterior tibial tuberosity. As a result of the direct blow over the anterior tibial tuberosity, this portion of the tibia was avulsed and with it the insertion of the quadriceps tendon.

The usual three day skin preparation for open operation was performed. A longitudinal incision was made lateral to the patella and was carried down to the crest of the tibia. Exposure of the tibial tuberosity revealed the avulsed portion of the bone containing fresh callus. The fragmented and torn portion of the quadriceps tendon was retracted upward and pinned on itself so that the entire infrapatellar portion of the quadriceps ligament had to be uncurled and replaced. Drill holes were then made around the avulsed cavity in the tibia. The avulsed tuberosity was then drilled in such a way as to permit double chromic No. 2 catgut to be placed and tied. (Fig. 8.) Three similar sutures were placed through the drill holes and tied over the tuberosity to keep the fragment in situ. Following this, lateral expansions of the quadriceps ligament were sutured and the entire infrapatellar portion of the quadriceps tendon, which was torn and jagged,

was sewed to itself with chromic No. 2 catgut. The joint capsule had been opened as a result of the original trauma and about 25 c.c. of bloody synovial fluid was removed at the time. The wound was closed in layers with chromic No. 0 and the skin closed with interrupted dermal sutures. A posterior moulded plaster splint which had been made prior to operation was then reapplied.

Diagnosis was infrapatellar rupture of quadriceps tendon with avulsion of the tibial tubercle.

The postoperative course was somewhat prolonged, owing to a superficial skin infection, but the posterior moulded Plaster of Paris splint was removed and the patient was allowed up on crutches on September 9, 1939. His power to extend his knee was excellent. (Figs. 5B and C.) At the time of discharge he could bend his knee to a right angle and extend it to the normal range. This man was given a follow-up examination on July 8, 1940, and the end result was regarded as satisfactory.

CONCLUSIONS

1. The varieties and types of ruptures of the quadriceps tendon are reviewed and classified.

2. The factors involved in the etiology and causation of this entity are examined.

3. Ruptures due to direct and indirect violence are discussed as are those of spontaneous etiology.

4. The pathologic anatomy involved in the varieties of rupture is discussed.

5. The trilogy of symptoms in cases of quadriceps rupture are pain, crepitus, and function loss.

6. The pathognomonic sign of suprapatellar rupture is the absence of fullness due to the quadriceps bursa.

7. The pathognomonic sign of infrapatellar rupture with or without avulsion of the tibial tubercle is an upward shift of the patella.

8. The treatment of recent injuries depends on the site of rupture, extent of laceration of the surrounding tissues, and the degree of function loss.

9. The successful treatment of late or delayed injuries will depend upon first, the ablation of all old cicatricial tissue; secondly, the restoration of the continuity of the tendon; thirdly, the rehabilitation of the quadriceps muscle; and lastly, the absence of any intra-articular complications.

10. The complications apart from the commonly encountered postoperative complications are due directly to (a) insufficient treatment and (b) the local or general individual predisposing causes of the accident.

11. Three operative cases are cited—two of which are suprapatellar ruptures and the third is an infrapatellar rupture with avulsion of the anterior tibial tubercle.

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THE FALLACY OF THE CONJOINED TENDON*

THE ETIOLOGY AND REPAIR OF INGUINAL HERNIA

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SINCE the time of Morton[1] and Roustan,[2] the literature is replete with the importance of the conjoined tendon in the repair of inguinal hernia. Bassini[3] in his method calls for the suturing of the conjoined tendon to Poupart's ligament. Halsted[4] required it, and many modern surgeons[5–8] following the same school utilize the conjoined tendon in the radical cure of hernia.

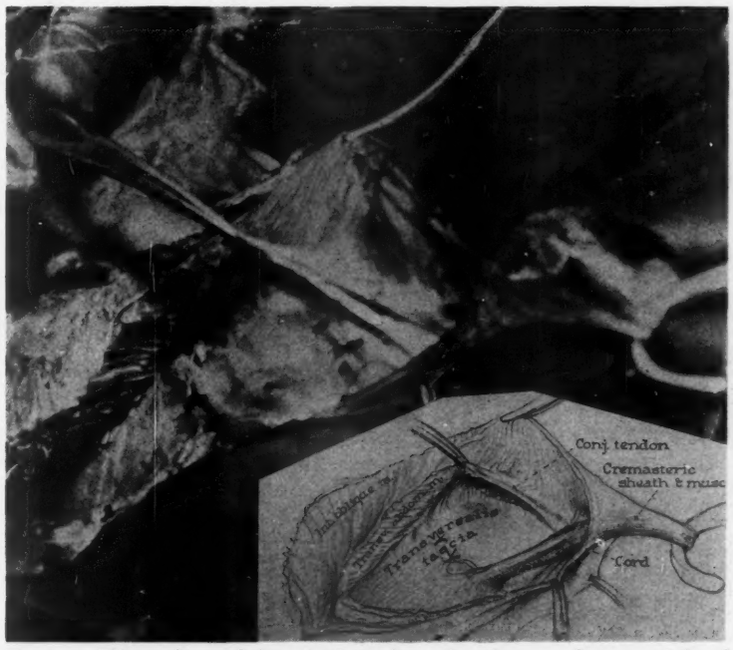

FIG. 1. Dissection of inguinal region showing perfect conjoined tendon.

During the past eight years, the author has specially dissected the inguinal region of twenty cadavers. Of this number, only two specimens possessed a conjoined tendon definitely discernible as a distinct structure. In one of these bodies, the conjoined tendon (Fig. 1), was well defined on the right side, while a few fan-like strands represented the transversus abdominis muscle on the left. Blake[9] dissected twenty-five normal muscular subjects and found no instance in which the conjoined tendon extended more than 5/8 inch lateral from the insertion of the rectus muscle. Several recent publications[10] have emphasized the wide structural variation present in this part of the body.

In view of these observations, the relative unimportance of the conjoined tendon either as a causative or a corrective agent in inguinal hernia has impressed me. It seems illogical to attribute properties to a structure so inconstant, and erroneous to incorporate it in the operative technique for the cure of hernia.

Confusion about the anatomic relations of the inguinal region makes the scientific understanding and repair of hernia impossible. The layers comprising this area are universally accepted as far as skin, superficial fascia, external and internal oblique muscles are concerned. Loose nomenclature of the remaining structure is partly to blame for the confusion. The abdomen pos-

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FIG. 2. Relationship of transversalis fascia to overlying structures.

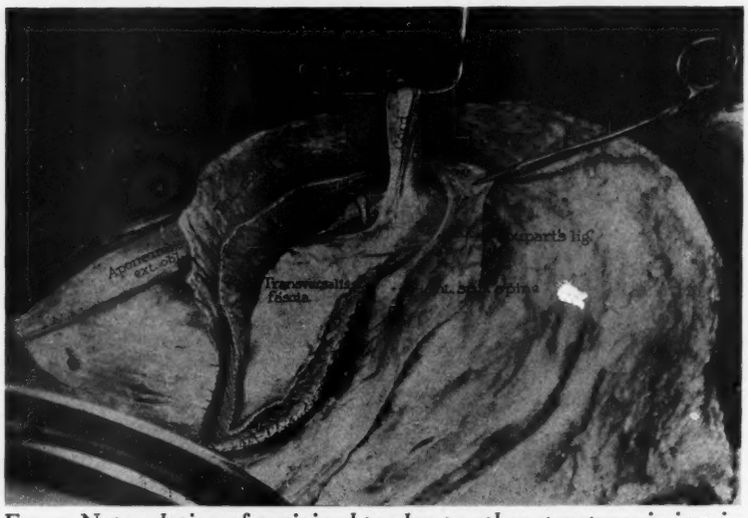

FIG. 3. Note relation of conjoined tendon to other structures in inguinal region.

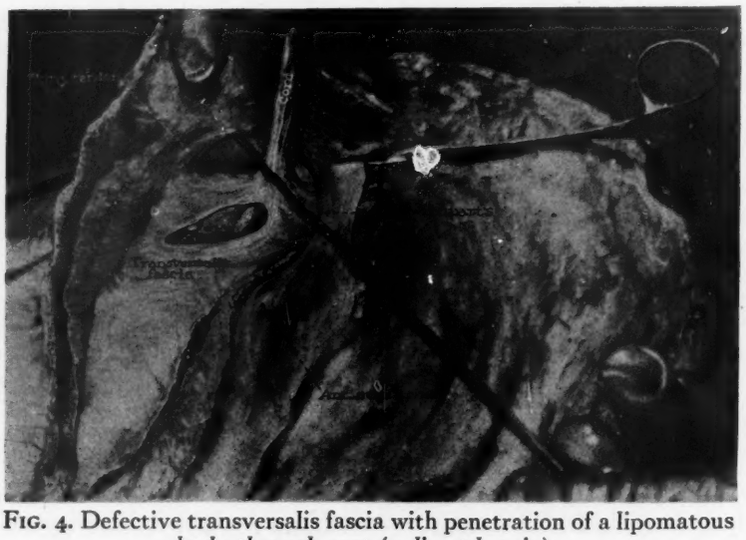

FIG. 4. Defective transversalis fascia with penetration of a lipomatous body through rent (a direct hernia).

sesses a third muscular layer, a distinct entity, always present, but at times thin and not uniform in its extent. This layer extends over the lateral abdomen down to the anterior-superior iliac spine, with fibers directed transversely. For this reason, the correct nomenclature properly regards this structure as the transversus abdominis muscle. It must be emphasized that this muscle is a definite entity and should not be confused with the strong, entirely aponeurotic layer lying beneath it, however intimate and entwining the fascicles. The transversus abdominis is muscular in its lateral portion and tendinous in its medial aspect, like the overlying internal and external oblique muscles. The transversalis fascia, however, is entirely aponeurotic, lies beneath all the above-mentioned structures, and has connection with the transversus abdominis muscle only by contiguity. (Fig. 2.) To call the transversus abdominis the transversalis muscle is obsolete, and begets ambiguity.

Where extant, the tendinous portion of the transversus abdominis muscle comes in contact with the lateral portion of the internal oblique muscle several centimeters above the pubic spine. This continuity is termed the conjoined tendon. (Fig. 3.) We repeat: *where such a structure exists.*

With these anatomic landmarks defined, our attention is directed to the consideration of the etiologic factor productive of a hernia.

Considering a hernia as a protrusion of a viscus through any part of the abdominal parietes, it is evident that the first layer immediately adjacent to the peritoneum must be defective or penetrated before the abdominal contents can escape. It is, in our opinion, to this layer that we must ultimately resort for an answer to the question of etiology and repair of hernia. An intact, strong, resisting transversalis fascia is incompatible with a hernia. Here is nature's first line of defense. No other single structure can replace it. Destroy its continuity, relax its aponeurotic plan, and you have potential pathology. (Fig. 4.)

Lack of uniformity in opinion regarding the distribution of this fascia arrests progress in the surgical understanding of hernia.

Fig. 5. Indirect hernia with infundibuliform fascial sac. Note relation of infundibuliform and transversalis fascias.

That the transversalis fascia plays an important rôle in the structure of the inguinal canal, everyone admits. The fact that the internal inguinal ring and the infundibuliform covering of the cord are part of that same fascia is, however, ignored. (Fig. 5.) The surgical floor of the canal is only a part of the broad aponeurotic sheath extending from Poupart's to Poupart's down to the symphysis pubis. The so-called "weak spot" is not attributable to a defective conjoined tendon, but rather to a badly relaxed or torn transversalis fascia. (Fig. 6.)

The etiology of direct hernia is clear. The simple closure of this defect by suture constitutes adequate repair for such a hernia, irrespective of what is done with the overlying structures by way of reinforcement. No matter how ingenious the latter, neglect of the former will produce disappointment.

The structures lying upon the transversalis fascia are not to be discarded as un-

important. Utilization of every available tissue is paramount. The present contention emphasizes the structure which rightly should receive foremost consideration in any planned herniorrhaphy.

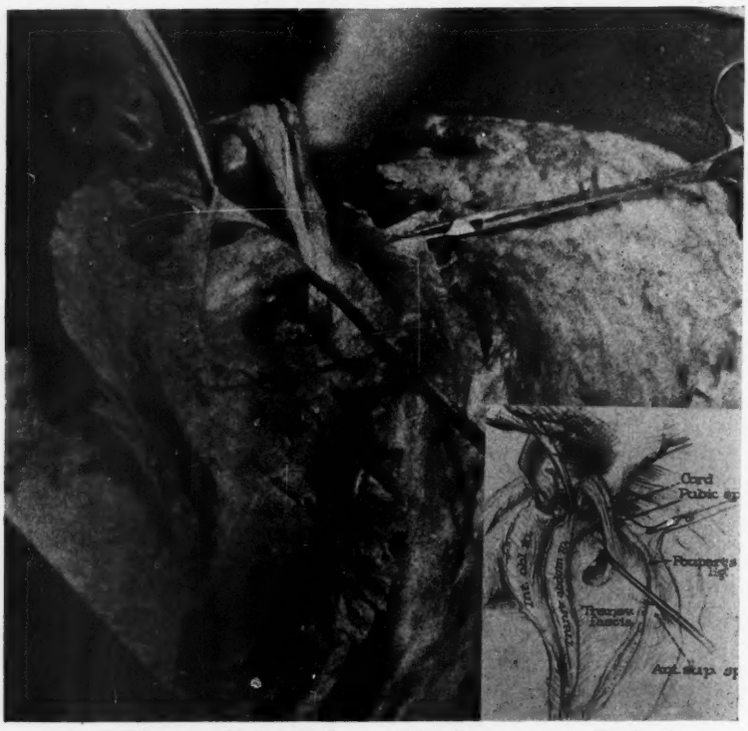

FIG. 6. The so-called "weak spot" in the transversalis fascia.

In indirect hernia of the cord, the importance of the transversalis fascia cannot be overestimated. A short inguinal ligament,[11,12] a defective, overlapping, internal oblique muscle,[11,13] or a relaxed external ring[14–16] may influence the appearance of the pathology. These are extraneous things, however; they are accidents which do not pertain to the essential causative principles in this type of hernia.

An anatomically perfect transversalis fascia comprising the internal inguinal ring is inconsistent with a hernia of the cord. (Fig. 7A.) On the other hand, the repair of this hernia, after the dissection, isolation, ligation and excision of the sac (Fig. 7B and C), involves the reconstruction of the internal inguinal ring. This may be accomplished adequately by a single purse-string suture that includes, besides the fascia, a bit of the cord and Poupart's ligament. (Fig. 7D and E.) The rent in the transversalis fascia is closed by interrupted sutures of chromic catgut or fine silk, and attached to the shelving edge of Poupart's ligament. (Fig. 7F.) Thus a second internal inguinal ring is created at the most distal part of the canal without grave interference in the morphology of this structure. The reconstruction of the external ring is accomplished by fascial imbrication of the lateral margin of the external oblique over to the fascia of the internal oblique, using a continuous chromic catgut suture. (Fig. 7G.) The operation is completed by superimposing the medial margin of the external oblique upon its lateral surface by means of the same continuous stitch. (Fig. 7H.)

SUMMARY

Many methods of hernial repair and their modifications have been devised. With some trepidation, the present one is submitted because of its anatomic soundness. This repair takes cognizance of the structural relationships in this part of the body without gross disturbance to their physiology.

The author acknowledges his indebtedness to Dr. Reuben Gaines for taking the candid camera illustrations.

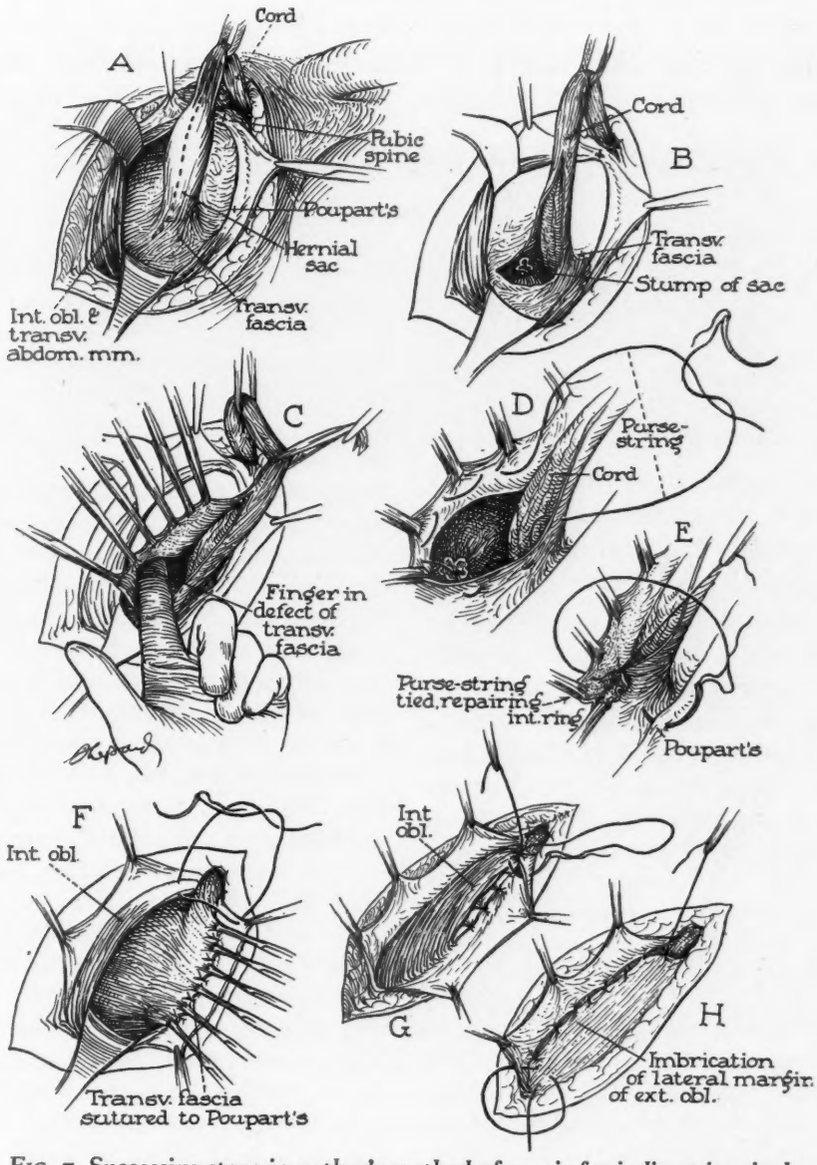

FIG. 7. Successive steps in author's method of repair for indirect inguinal hernia.

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THE SURGICAL IMPORTANCE OF ACCESSORY SPLEENS

WITH REPORT OF TWO CASES

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ACCESSORY spleens are uniformly described by anatomists, frequently seen by the pathologist in the autopsy room, but seldom noted by the surgeon at operation.

A review of the literature reveals comparatively few cases in which surgical conditions were occasioned directly by the presence of accessory spleens. The majority of the reported cases have produced subacute or chronic manifestations clinically. However, acute pathologic changes may occur in intra-abdominal accessory spleens and give rise to acute surgical emergencies, in which the clinical signs and symptoms are those of an "acute surgical abdomen" of obscure etiology. This fact is well illustrated by the two cases here reported.

CASE 1. S. G., a 4 year old male child, was admitted April 20, 1935 with a chief complaint of generalized abdominal pain. This had begun three days prior to admission and had been followed by nausea and vomiting. Twenty-four hours later the child developed chills and fever. There had been no bowel movement for twenty-four hours. The past history was unimportant, except that for two years the child had occasionally cried with abdominal pain.

Physical examination revealed an acutely ill child crying in pain. The temperature was 102.4 degrees rectally, the pulse 120 beats per minute. The skin was dry. The abdomen was quite distended and tympanitic, with moderate rigidity and tenderness throughout and the point of greatest tenderness was in the left upper quadrant. Peristaltic sounds were not audible. The liver, spleen, and kidneys were not enlarged and there were no palpable masses.

The laboratory examination was not remarkable except for a leucocytosis of 21,000 with 92 per cent neutrophiles.

Roentgen examination by barium enema revealed an extrinsic filling defect and deformity of the colon at the splenic flexure with gaseous "distention" and "staircase" effect in the proximal loops of small bowel.

Eight hours after admission the abdomen was opened through a left rectus incision. About 300 c.c. of cloudy, straw colored fluid was present free in the peritoneal cavity. Several fibrin covered loops of small bowel and the colon at the hepatic flexure were adherent to an orange-sized mass in the left upper quadrant, the kinking producing an obstruction in the proximal small bowel. The loops of bowel were dissected away revealing an encapsulated tumor mass attached by a 2 inch pedicle, the base of which sprang from the gastrosplenic ligament. The mass was quite soft and covered with fresh fibrin, evidence of acute inflammation. This was due to torsion of the pedicle producing a complete strangulation. The pedicle was ligated and the mass removed in toto. The spleen was palpated and found to be of normal size, shape and position. The abdomen was closed without drainage and recovery was uneventful.

The specimen was an encapsulated tumor mass, ovoid in shape, measuring 6 by 6 by 7 cm. and weighing 125 Gm. At its base there was a thick fibrous pedicle stump, ligated close to the capsule. (Fig. 1.) Elsewhere the capsular surface was quite smooth except for numerous old and recent fibrous tags, evidence of adhesion to adjacent structures. The capsule 2 mm. thick was covered with flaky fresh fibrin. The cut surface of the mass presented a deep red appearance, with numerous interlacing fibrous trabeculae and many small islands of soft gray tissue. The consistency was extremely soft. The parenchyma everted above the cut surface. (Fig. 2.)

Sections showed a general architecture identical with that of splenic tissue. The capsule was quite thickened and covered with polymorphonuclear leucocytes and fibrin. Fibrous trabeculae extended from the capsule into the parenchyma. The pulp was densely infiltrated with polymorphonuclear neutrophiles, the si-

nuses stuffed with erythrocytes. Extensive areas of hemorrhage and necrosis were present and splenic nodules were numerous. The pathologic diagnosis was complete infarction of an accessory spleen.

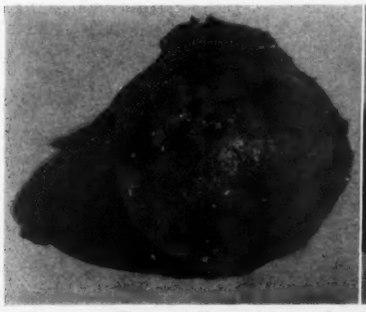

Fig. 1. External surface of accessory spleen showing pedicle stump.

Fig. 2. Cut surface of accessory spleen, showing fibrous trabeculae, germinal centers and soft pulp.

Case II. H. C., an 8 year old female, January 14, 1937 complained of abdominal pain. The illness had begun about eighteen hours prior to admission when the patient was awakened from sleep by epigastric pain sharp and constant in character. A few hours after onset it became localized in the mid-abdomen. Emesis occurred about thirty minutes after onset and had continued at infrequent intervals. The past history was irrelevant.

The child lay flat in bed and was moaning with pain. The temperature was 99.6°F. orally, the pulse 100 beats per minute. The abdomen was flat. There was slight tenderness to palpation over the entire anterior abdominal wall, most marked over the left upper quadrant to the left of and above the umbilicus. Moderate rigidity was present in this area but absent elsewhere. An indistinct, tender, movable lemon-sized mass was palpable in the left upper quadrant three fingerbreadths below the left costal margin. The kidneys, spleen or liver were not palpable. The extremities and the reflexes were normal.

The only significant laboratory finding was a leucocytosis of 13,000, the distribution being within normal limits.

A flat film of the abdomen showed no abnormality and examination of the colon by a barium enema revealed no deformity or filling defect.

Laparotomy was performed six hours after admission. The abdomen was opened by a high left rectus incision. The exploring hand immediately encountered a mass in the left upper quadrant which was covered with folds of omentum anteriorly. The mass was delivered into the wound, the early cobweb-like adhesions with the omentum were separated with ease and the pedicle of the mass was doubly ligated and amputated close to its base at the left lower border of the gastrocolic ligament. The pedicle was composed of delicate fibrous fatty tissue and the vessels contained therein, which formed the blood supply to the tumor, were quite dilated and tortuous. The encapsulated mass was quite tense, the distal portion of the pedicle slightly inflamed, and it was thought that the signs and symptoms were definitely due to torsion of the mass on the pedicle.

The mass was spherical and encapsulated, 2 by 3 by 3 cm. in size, and attached to a thin loose fatty connective tissue pedicle 3.3 cm. in length. The capsule was covered with several fibrofatty tags. The cut surface had a deep reddish purple appearance.

The histologic appearance was identical with that of splenic tissue. The sinuses were congested with erythrocytes. Many lymphoid cells and a moderate number of polymorphonuclear leucocytes were scattered through the reticulum.

The pathologic diagnosis was mild acute splenitis in an accessory spleen.

A careful search of the literature does not show a case report in which an accessory spleen reached the size of that in Case I. No doubt the size was considerably increased by the duration of the acute inflammatory process. However, the finding bears out generally the contention that accessory spleens are larger in infancy and early childhood. Since the incidence is greater in this age group, it is surprising

that the great majority of the reported cases in which clinical manifestations occurred have been in adults.

Diagnosis. Since torsion of an accessory spleen on its pedicle constitutes by far the most frequent cause for surgical interference, and because the correct diagnosis was established preoperatively in but one instance (Alexander) among those cases reported, the diagnostic findings should be considered. The diagnosis is usually obscure. As in the cases here reported, vague abdominal pain—with or without fever, nausea, vomiting, leucocytosis or partial intestinal obstruction—plus the presence of a tender mass in the region of the pain, sometimes accompanied by muscular rigidity and abdominal tenderness, should at least suggest this condition.

Clinical Manifestations. It is only recently that the clinical importance of the accessory spleen has been emphasized, since it seldom gives rise to symptoms.

Accessory spleens may produce clinical manifestations not only by (1) mechanical interference, but also (2) by inflammation, (3) by neoplastic change, and (4) by compensatory hypertrophy following primary splenectomy.

1. Mechanical interference may be produced by torsion on the pedicle, as in the cases reported above, or by pressure symptoms due to enlargement, interfering with intestinal peristalsis or giving rise to actual intestinal obstruction.

Alexander and Romanes report the case of a 25 year old female with recurrent attacks of unexplained upper abdominal pain in which laparotomy revealed an accessory spleen attached to the greater omentum and producing symptoms by torsion on its pedicle.

Alexander later reported a similar case of a 35 year old housewife with recurrent attacks of pain in the left upper quadrant and an intermittently palpable movable mass in this area. Laparotomy revealed an accessory spleen attached to the gastrohepatic omentum by a 3 inch pedicle. Removal was followed by complete recovery.

Temoin describes the case of a 35 year old female who complained of a painful lump in the abdomen for eighteen years. Laparotomy revealed an accessory spleen in and beneath the omentum with adhesion of numerous loops of small bowel, producing symptoms by kinking and interference with mesenteric circulation.

In Voss' case, the patient complained of increasing attacks of pain in the left hypochondrium for several years. At laparotomy, an accessory spleen was found on the anterior surface of the transverse colon 2.5 cm. from the splenic flexure. Symptoms were due to interference with peristalsis.

2. Inflammatory lesions. Accessory spleens may undergo inflammatory changes identical with those occurring in the primary spleen. During the acute infectious diseases, the changes producing acute splenic tumor may be coincident in accessory organs. A case was called to the author's attention in which a painful enlargement of the scrotum of an adult male occurred during the acute febrile course of a tertian malaria. An enlarged accessory spleen was found in the scrotum at operation.

3. Neoplastic lesions. Accessory spleens may undergo neoplastic change. In the leucemias they may take on the changes usually found in the primary spleen. They may be involved simultaneously with the spleen in the lymphoblastoma group.

4. Compensatory hypertrophy. Accessory spleens may hypertrophy following primary splenectomy; this fact, as pointed out by Curtis and White, is of great surgical significance. If they are left behind at operation they may subsequently enlarge and the symptoms for which the original splenectomy was performed may recur. Morrison, Lederer and Fradkin report a case of essential thrombocytopenic purpura in a 21 year old female where splenectomy was done, but a walnut-sized accessory spleen which was found at the time of operation was not removed. Following operation immediate improve-

ment occurred but was followed by gradual recurrence of the disease to the preoperative level. It was thought the presence of the accessory spleen accounted for the recurrence of symptoms. These authors argue that a small primary spleen is apt to be accompanied by additional compensatory splenic bodies.

Warthin and Mayo (quoted by Alexander and Romanes) contend that if the primary spleen is functionally or structurally deficient there is a compensatory hyperplasia of accessory splenic tissue. Thus it would appear timely to search for and remove accessory spleens at the first operation. In any case of essential thrombocytopenic purpura or congenital hemolytic icterus where symptoms recur following splenectomy, the possibility of regeneration of an accessory spleen should be considered.

Accessory spleens occur with comparative frequency (10 to 35 per cent) in the abdominal cavity; more rarely in the scrotum, liver and pancreas. Intra-abdominal accessory spleens occur with greater frequency in childhood.

The number of accessory spleens described in individual cases varies from one or two to 1000.

The location of accessory spleens varies. According to Schilling, the most frequent sites are: (1) hilus of the spleen; (2) gastrosplenic ligament; (3) splenocolic ligament; (4) great omentum; (5) pleurocolic ligament; (6) peritoneal tissue along the great splenic vessels, (7) pancreas. Hempelmann describes the lesions as "usually a small bud of splenic tissue situated between the peritoneal folds near the hilum, but they may appear in any part of the abdominal cavity."

Accessory spleens generally vary in size from 2 or 3 mm. up to 4 cm. in diameter. They are encapsulated and of the color and consistency of normal spleens. They may be sessile or pedunculated, and in the latter case one or more smaller bodies are frequently found lying within the pedicle of a larger.

The accessory spleen is an anomaly. It occurs following trauma or as a result of a developmental abnormality in embryo.

SUMMARY

Two cases in which acute surgical emergencies were produced by torsion of an accessory spleen on its pedicle are presented. The importance of accessory spleens to the clinician and surgeon is emphasized. They may produce clinical manifestations by mechanical interference, by inflammation, by neoplasia or by compensatory hypertrophy following primary splenectomy. Accessory spleens occur with comparative frequency in certain locations in the abdomen and scrotum, rarely in the pancreas and liver. Their presence may be accounted for by trauma to the primary spleen with subsequent transplantation of splenic tissue or by developmental changes in embryo.

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Sterility of the operative field is impossible to obtain in surgery of the rectum and anus except in a few operations which are performed through a perianal skin incision without entering the bowel lumen.
From—"The Rectum and Colon" by Hayden (Lea & Febiger).

OPERATION FOR GREATER MOBILIZATION OF THE TRANSVERSALIS FASCIA IN THE REPAIR OF DIRECT INGUINAL HERNIAE

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THE importance of the transversalis fascia in the repair of direct inguinal herniae has long been recognized and many procedures described to utilize it to its fullest extent. In direct inguinal herniae, however, the ruptured fascia is so frayed and thinned out that attempts to suture it together or to suture it to other structures are not very efficient. It is particularly difficult in a direct hernia of any size to identify this attenuated ruptured fascia.

Since 1933 an operation has been used for all direct herniae, which utilizes a strong, well developed band of fascia, formed by the fusion of transversalis aponeurosis and transversalis fascia. This is obtained by splitting longitudinally the internal oblique muscle and pulling this fascial band, which is particularly developed, through the muscle and suturing it to Poupart's ligament. The new fascial floor of the canal extends from the level of the pubic spine to just below the lower edge of the cord as it emerges from the internal inguinal ring. This firm fascial layer is then supplemented by the Bassini closure.

In this operation the usual skin incision is made. The aponeurosis of the external oblique is opened and reflected, exposing the cord beneath the cremasteric muscle. An indirect sac is found by incising the cremasteric muscle and infundibuliform fibers of the transversalis fascia. The indirect sac is isolated and opened and the direct sac pulled up beneath the epigastric vessels, converting it into the indirect sac, according to the maneuver of Hoguet. This is then transfixed and reduced in the usual way. The cord is retracted inward by two small retractors and the distinct shelving edge of the transversalis muscle is identified beneath the overlying internal oblique muscle.

With a blunt-pointed scissors or a hemostat, at about the upper middle, midway between the pubic spine and the internal inguinal ring, the internal oblique muscle is perforated and widely split longitudinally about 1 cm. from its margin down to the aponeurotic fascia. This is done by opening the blades of the scissors. The fascia is recognized as a glistening white fascial band with longitudinal striations. It is grapsed with a forceps and pulled through the muscle and, by gentle traction and the addition of other forceps, is freed from the overlying musculature and separated by blunt dissection from just below the emergence of the cord at the internal ring down to the pubic spine. The outer edge of the longitudinally split muscle is allowed to drop below the fascia, the fibers of which, together with a few of the split fibers of the internal oblique which may be included in the distal portion of the muscle, by a reparative fibrosis, add to the subsequent strength of the repair.

The transversalis fascia and aponeurosis is sufficiently mobilized by pulling downward and outward towards Poupart's ligament until, without any tension whatever, it overlaps the edge of the ligament. The broad, strong fascial band, which has been pulled through the outer margin of the muscle, is then sutured to the ligament by interrupted silk sutures from just below the level of the cord as it emerges from the ring. The sutures should be placed about 1 cm. apart and should firmly overlap the edge of the fascia on Poupart's ligament. This can

be carried down, in a majority of cases, to the level of the pubic spine without any tension.

In about 20 per cent of the cases the lower portion of the transversalis aponeurosis and fascia is so fused with the ligamentous portion of the internal oblique forming the conjoined tendon that it cannot be separated all the way to the spine without tension, but in the vast majority of cases it forms a thick, distinct, well developed fascial layer to the pubic spine.

Care must be taken in inserting the suture not to press too closely to the cord, as there is apt to be tension in the upper portion. If the cord is impinged upon, circulatory changes may result in atrophy of the testicle. It is important that none of the sutures be under tension.

The wound is closed in the usual manner, following the Bassini method. The remains of the conjoined tendon, transversalis muscle and internal oblique muscles are approximated and sutured to Poupart's ligament, care being taken to place these sutures between the previous ones, thus preventing any possible hiatus of the fascia. The sutures not only include the muscle, but pick up also the edge of the fascia as it overlaps Poupart's ligament. These are carried in the usual manner through Poupart's ligament, with transplantation of the cord. By this procedure the direct space is well closed by an extra fascial layer of unusual strength. Silk technique is employed in closure.

CONCLUSIONS

This procedure has been used in approximately 400 cases, which have been followed by check-up inspections since 1933. There have been six recurrences, of which three have been reoperated, giving a recurrent rate of about 1.5 per cent. The number of cases is too small and the time elapsed too short to give complete end results, but the procedure seems rational and effective.

LOBECTOMY FOR BRONCHIECTASIS*

REPORT OF TWO CASES

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THE groundwork for the more recent progress in the treatment of bronchiectasis, a hopelessly progressive disease which ultimately totally incapacitates, can be attributed to the combined efforts of the clinician, the bronchoscopist, the roentgenologist, the anesthetist and the surgeon. A voluminous literature records the efforts of earlier investigators who laid the foundation for every phase of the subject. No longer need the clinician look with despair on the outcome of surgery. The early recognition of the disease, and the realization of the limitations of conservative therapy should prevent metastases in the brain or kidney and possibly limit simple bronchiectatic suppurations before they become septic, with the obvious increased surgical hazards.

Factors of undisputed importance in the reduction of the mortality from surgery are: the utilization of the more recent developments in accurate diagnosis, especially after the instillation of iodized oil into the bronchial tree; preoperative postural and bronchoscopic drainage; supportive treatment such as transfusions; improvements in anesthetic agents and their administration; and the use of the oxygen tent postoperatively in diminishing anoxemia. Factors of a possibly controversial nature, which have in the hands of different investigators given variable results, include: the proper evaluation of the rôle of pneumothorax; the creation of adhesions to immobilize the upper lobe to limit infection and facilitate lobectomy; and the choice of a one- or two-stage operative procedure. These achievements are evidence of a wide participation of many investigators in the development of the surgical therapy. It is now generally recognized that lobectomy or pneumonectomy is the only method of treatment that permanently relieves the patient of this disease.

Etiology. Residual chronic infections of the respiratory tract superimposed on a mild influenza, measles, scarlet, whooping cough and pansinuisitis, or the aspiration of a small foreign body are causative factors which often lose their significance because of the comparative mildness of the symptoms. These may be present for many years before the underlying morphology is appreciated. In the second case reported here, the onset of symptoms dated back seventeen years to a protracted "bronchitis." Numerous observers noted the frequency with which the inception of the disease could be traced to a comparatively early age and commented on the span of years before disease was properly evaluated and corrective measures instituted.[14] Bohrer[3] states that 50 per cent of adults with bronchitis date the genesis of their disease to childhood.

Smith[5] stresses the importance of fusospirochetae in the diseased mouth as a source of infection. He commented on the large percentage of cases of pulmonary suppuration attributable to these organisms.

Watson and Kibler[6] reported a definite association of allergic diseases in 90 per cent of the cases of bronchiectasis under their observation in Arizona. They noted the frequency with which patients with allergic nasal trouble and sinusitis had a coexisting bronchiectasis and in whom the bronchial secretions presented an abnormally high percentage of eosinophiles. They

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quote Hansel[7] as having found allergic manifestations and abnormal amounts of eosinophiles in the nasal secretions in 44 per cent of patients seeking relief for nasal trouble.

Diagnosis. Importance factors influencing the course of treatment and the prognosis are the interpretation of the results of the various diagnostic procedures utilized in determining the presence and the extent of the bronchiectasis.

(*a*) *Bronchoscopy*[8] will exclude the presence of a foreign body or tumor. It will also determine the presence of narrowing or occlusion and the precise source of the expectoration.

(*b*) *Bronchography.*[9] The instillation of iodized oil in both bronchi and their tributaries will accurately determine the extent and distribution of saccular or cylindrical dilatation. Instillation of lipiodol in the upper lobes should be done by means of a catheter under the guidance of the fluoroscope on a tilt table. By this means other pulmonary diseases can be excluded, particularly tuberculosis, abscess of the lung or the presence of a new growth.

(*c*) *Cytological Examination.* Uncontaminated secretions obtained on aspiration by means of the bronchoscope should be cultivated for bacteria and spore-bearing anaerobes. Smears of the secretion stained with gentian violet or dilute carbolfuchsin as suggested by Smith[5] should be examined for the fusiform bacilli and thicker spirochetes (*Treponema buccale* and *Treponema vicenti*). The bronchial and nasal secretions should be examined for eosinophiles to establish possible allergic background.[6]

(*d*) Cutaneous allergic tests should be carried out.

(*e*) Accessory sinuses should be radiographed for cloudiness. Its possible allergy should be borne in mind.

Classification. Before the methods of treatment can be evaluated, numerous basic factors having a direct bearing on the ultimate outcome must be considered. The lowest mortality has been reported in the comparatively dry nonputrid cases. The septic and putrid cases of bronchiectasis have accounted for the higher mortality because of the obviously increased surgical risk. The age of the patient, the duration of the disease, the extent of the infectious process, the extent of parenchymal pneumonitis, coincident abscess, the febrile state and character and amount of sputum, all have a direct bearing on the ultimate result of any method of therapy.

Every sufferer with bronchiectasis should be classified in a distinct group to standardize, if that is possible, a method of approach to the problem, that would lessen the precariousness of surgery. Archibald's[10] grouping into three classes is an arbitrary one into which most of the patients can be fitted from both a therapeutic and a prognostic standpoint. Briefly, Archibald's aseptic or dry group includes those cases of chronic bronchitis in which lipiodol filling shows cylindrical dilatation without evidence of abscess. These patients cough a moderate amount of mucoid or mucopurulent sputum and are generally afebrile. Early recognition of this group by bronchoscopy and bronchography will exclude cases of tuberculosis, asthma, bronchitis, and unresolved pneumonia. Surgical treatment in this group has been attended with the lowest mortality. The second group of patients includes those distressed by cough, with drainage of a fair amount of foul sputum. Pneumograms reveal small cylindrical fusiform sacculations, thickened parenchyma but no clearly defined abscess. Fever accompanies retention of secretions. This group may border on the third class if complicated by pleurisy or empyema. Such patients may be semi-invalided for years with wide variations of disability or they may get worse and pass into the third class. Patients in this third group suffer from chronic sepsis, are frequently febrile and dyspneic on exertion. They may also cough frequently, have foul and abundant sputum and tend to show clubbing of the fingers. The *x*-ray reveals a diffuse shadow of unresolved pneumonitis, with thickened pleura

from empyema which has drained and healed. Lipiodol studies show cylindrical fusiform and saccular dilatation with frequent abscesses. Drainage of expectoration is free but not adequate. Archibald stresses the situation of this type of patient who has frequently had postural and bronchoscopic drainage, with climatic treatment. They come to the surgeon in a precarious condition so that lobectomy is attended with a high mortality. Obviously there is no sharp line of demarcation in these groups. The prognosis is best in the first class and becomes more grave as the patient becomes septic and the lung becomes putrid. Archibald doubts the validity of lobectomy in the first group unless the condition is aggravated as a result of an intercurrent pneumonitis such as to bring these patients into the second class.

Treatment. Effort should be made to exclude the association of nasal allergy causing a basal allergic bronchitis.[6] Where evidence of fusospirochetal infection is present, treatment with arsenical preparations should be instituted.[5] The use of large doses of radiotherapy to affect the secreting mucous membrane has been reported by Berck and Harris;[11] great improvement followed in a considerable number of the thirty cases so treated.

Failure to influence the disease favorably by rest, postural and bronchoscopic drainage, radiotherapy, intravenous therapy with neoarsphenamine, vaccine therapy or by a change in climate justifies serious consideration of surgery. Waiting until a comparatively dry bronchiectasis develops some intercurrent infection which will activate the disease and probably render the case septic or putrid enhances the difficulties of surgery and may be followed by grave consequences. Further procrastination may result in spreading to other parts of the same lung or to the contralateral lung. Complications such as recurrent pneumonia, pulmonary abscess, empyema, cerebral or kidney abscess may develop. It is generally conceded that lobectomy or pneumonectomy offers the only permanent relief for patients suffering with bronchiectasis who have failed to respond to conservative therapy.

Choice of Operative Procedure. The advantage of the choice of one- or two-stage procedure is still the subject of discussion and contention. Each case should be treated on its individual merits. Bohrer[3] collected forty-one cases in children, with a mortality of 34 per cent after lobectomy; twenty-three patients had a lobectomy in one stage, with 39 per cent mortality, and sixteen in two stages, with a 40 per cent mortality. In his own series of five cases, four had a two-stage and one a one-stage operation; four lived and one died. Lanman[4] reported ten cases in children, seven lobectomies and three pneumonectomies, all in one stage, with an operative mortality of 10 per cent. There are numerous advocates of the one-stage operation of Lilienthal[12] and Brunn,[13] and an equal number favoring Alexander's[14] two-stage procedure.

It is generally contended, that if the upper lobe could be fixed by adhesions to the chest wall, the extent of both infection and respiratory embarrassment would be limited and the hazards of lobectomy would be appreciably lessened. Graham's[15] objection to Alexander's method of creating adhesions by wiping the visceral and pariental pleura with gauze, is that this results in excessive fixation of the lung to the chest wall and obliteration of the interlobar fissure. The numerous methods to create adhesions for anchoring the upper lobe to the chest wall have not all been uniformly satisfactory.

Bethune[16] has advocated the use of ½ per cent iodized talc powder. Under thoracoscopic guidance in a closed pneumothorax this is blown on to the surface of a partially collapsed upper lobe by means of a powder blower.

Churchill[17] contends that a middle ground should be taken and that the chief virtue of a two-stage operation is the limitation of infection to a small pleural cavity. He believes that a two-stage operation is

easier and in the presence of a free pleural cavity there is less septic convalescence.

The two patients reported in this paper

Fig. 1. Case 1. January 10, 1934, bronchoscopic instillation with lipiodol, showing a compressed right bronchus with a large, wing-shaped shadow extending obliquely forward and outward and the other wing backward and outward.

were operated upon in one stage. One case was associated with a pulmonary abscess and moderate sepsis following pneumonia and empyema. In the other case, a comparatively simple bronchiectasis after seventeen years became putrid during the last six months before the operation. Both developed a mild form of empyema but their subsequent convalescence has been uneventful.

Case 1. I. B., age 30 years, married, with four children, entered the hospital April 13, 1933 with a right lower lobar type 4 pneumonia. Her temperature gradually returned to normal on the fourteenth day. On April 29, the seventeenth day of illness, 300 c.c. of thin turbid fluid was withdrawn from the right pleural cavity. Culture showed *Streptococcus hemolyticus*. On May 6, thick yellow pus was evacuated through an intercostal incision. Flapper tube drainage was maintained until there was no discharge from the wound. On May 24, expectoration became foul and a diagnosis of lung abscess was entertained. Postural drainage outdoors resulted in a general improvement.

The patient was discharged on June 28 with radiographic evidence of complete expansion of the right lower lobe. There was no cough or expectoration and the wound was healed.

She was readmitted on September 15, 1933 with a nonproductive cough and evidence of reaccumulation of pus in the pleural cavity. On September 19 1½ inches of the seventh rib were resected. The culture of the pus evacuated from the pleural cavity again showed *Streptococcus hemolyticus*. She was discharged to the out-patient clinic on October 27, when there was no further drainage from her incision.

She was readmitted for the third time on December 21, with a history of fever, chills, productive foul expectoration with intermittent drainage from the empyema sinus. A flapper tube was reinserted through the old incision and considerable pus was evacuated. Trendelenburg postural drainage was again resumed effectively. Within a few days the temperature was normal, the expectoration and discharge from the wound became scant. On January 10, 1934, bronchoscopic examination with lipiodol (Fig. 1) by Dr. Robert Moorhead showed a compressed right bronchus and a large wing-shaped shadow extending obliquely forward and outward and the other wing backward and outward. These bronchiectatic cavities did not have radiographic evidence of external communication.

On January 12, nine months after the onset of pneumonia, the right lower and middle lobes were removed in one stage under avertin and nitrous oxide and oxygen anesthesia. The pleural cavity was exposed by resecting the fifth and sixth ribs. A Lilienthal rib spreader was used. The right lower lobe was found to be firmly adherent to the chest wall and diaphragm. The pedicle was ligated with three silk braided sutures. After carbolization of the bronchial stump, the bronchus and branches of the pulmonary artery and vein were then ligated separately with chromic sutures. Two rubber tube drains and the silk pedicle suture were brought out through a small wound in the sixth interspace. The patient was transfused with 400 c.c. of blood at the completion of the operation.

The tubes were removed on the fourth day and a flapper tube was reinserted. Drainage

was purulent and profuse for several days. The patient, in good general condition, was discharged to the out-patient department on February 5, 1934, with a discharging sinus.

and some pus were evacuated. She was discharged from the hospital on July 28, 1934, with the wound healed. It has remained healed ever since.

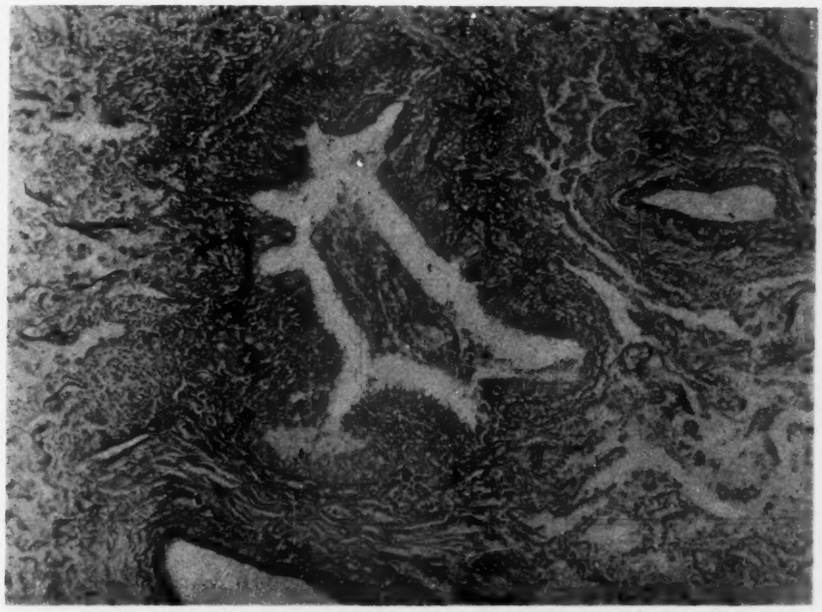


Fig. 2. Case 1. Weigert's elastic stain of bronchus. The wall of the bronchus shows disruption of the elastic membrane and mononuclear cell infiltration.

Fig. 3. Case 1. February 16, 1937, lipiodol study, revealing contrast media evenly distributed in the right upper lobe. The upper lobe had expanded to the lateral chest wall and to the elevated dome of the diaphragm.

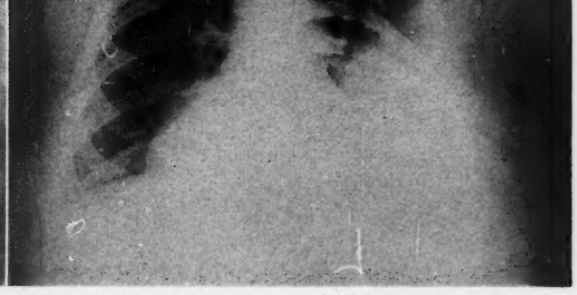


Fig. 4. Case 1. May 16, 1939. Partial narrowing of the right thoracic cavity and marked thickening of the pleura in the right lower half. The thoracic cavity is occupied by the expanded right upper lobe in the upper half of the chest. There is no displacement of the mediastinum.

The pathologic report showed a chronic pneumonitis with fibrosis of the lung and cylindrical bronchiectasis and chronic adhesive pleuritis. (Fig. 2.)

On June 19, 1934, the patient was again admitted, with the sinus discharging. This wound was enlarged. The three silk ligatures, which were found loose in the pleural cavity,

In February, 1937, lipiodol studies revealed the contrast media evenly distributed in the right upper lobe. The upper lobe has expanded to the lateral chest wall and to the elevated dome of the diaphragm. (Fig. 3.)

The patient has since given birth to another child, labor being smooth and without any embarrassment of the cardiorespiratory system.

Radiographic examination on May 16, 1939, revealed partial narrowing of the right thoracic cavity and marked thickening of the pleura

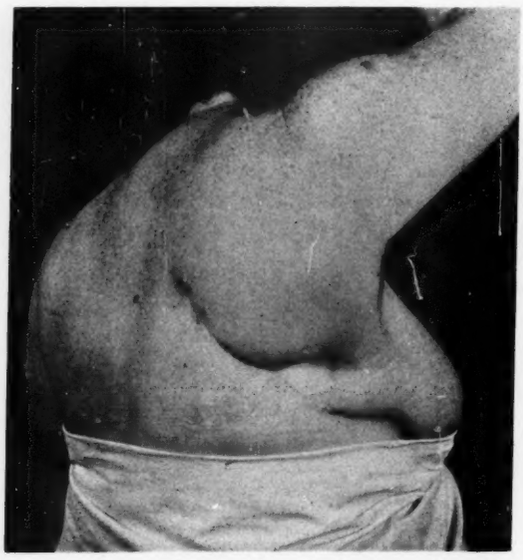
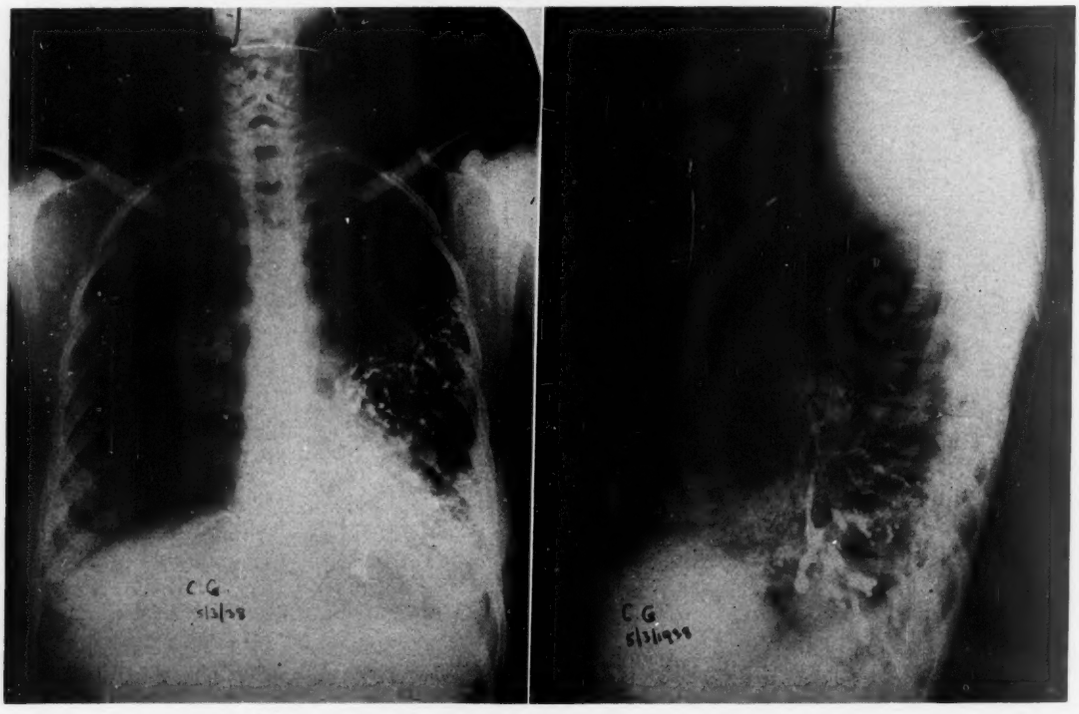


Fig. 5. Case 1. Five years after removal of the right lower and middle lobes.

in the right lower half. The thoracic cavity was occupied by the expanded right upper lobe in the upper half of the chest. There was no displacement of the mediastinum. (Fig. 4.) In June, 1939, five years after operation, the patient was able to climb stairs and scrub floors without respiratory embarrassment. (Fig. 5.)

Case 11. A woman, 25 years of age, married, with two children, for seventeen years had had a troublesome cough with profuse expectoration. For the previous five months the sputum had become foul and offensive. The only previous history of illness that could be elicited was a persistent "bronchitis" during childhood which was activated by frequent "colds and laryngitis." Every morning for seventeen years she awakened with a harrassing cough and produced large amounts of yellowish "phlegm." Occasionally she had pains in the left side of her chest. These symptoms became aggravated during the last year and for the five months before admission the expectoration became so profuse (6 to 10 ounces) and offensive that she sought admission to a hospital.

Ours was the third institution in which bronchoscopic and lipiodol studies revealed numerous saccular and fusiform bronchiectatic cavities involving the entire lower left lobe to the periphery of the lung. (Fig. 6.) The left upper lobe and the right lung upon fluoroscopic and lipiodol *x*-ray examination showed no pathology.



A B

Fig. 6. Case 11. Lipoidol studies by bronchoscopic instillation. Numerous saccular and fusiform bronchiectatic cavities involve the entire lower left lobe to the periphery of the lung.

The patient weighed 130 pounds; her breath was foul; and there was a diffuse enlargement of her thyroid. There was marked clubbing of the fingers and slight clubbing of the toes. She tired readily on the slightest exertion. Over the left base there were diminished resonance, roughened bronchovesicular breath sounds with sibilant and sonorous râles. Repeated sputum examinations for tubercle bacilli were negative as were other cytologic examinations. Hematologic examinations were essentially negative.

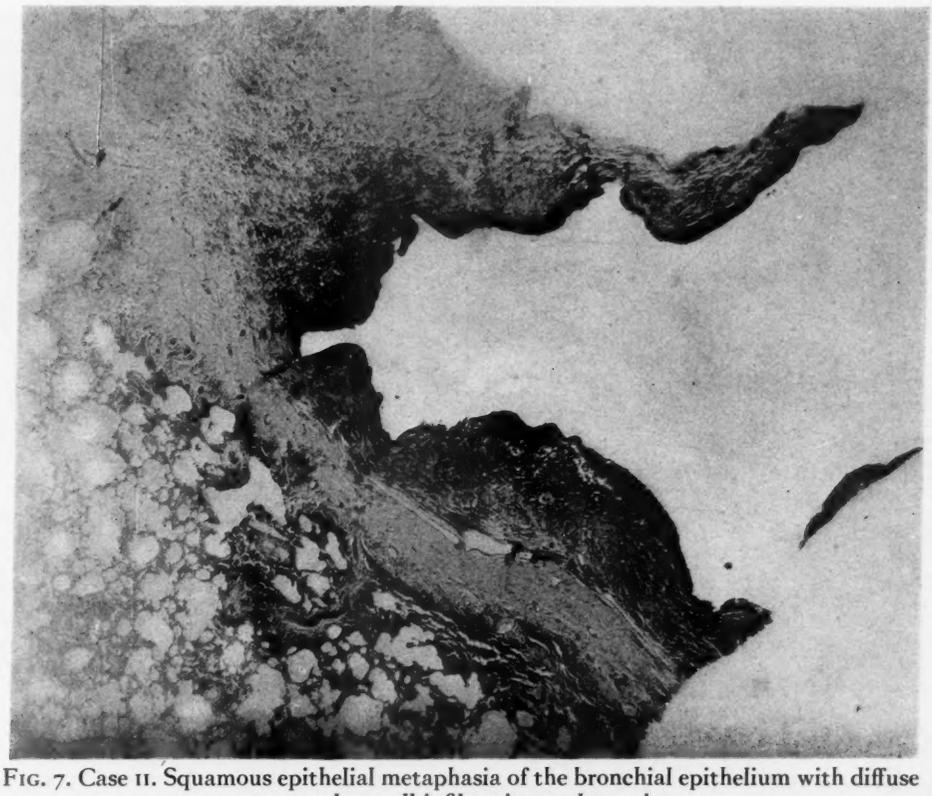


Fig. 7. Case 11. Squamous epithelial metaphasia of the bronchial epithelium with diffuse mononuclear cell infiltration and scarring.

Supportive treatment included a transfusion, postural and bronchoscopic drainage, and sleeping in the Trendelenburg position.

At operation on May 10, 1938, seventeen years after the onset of symptoms and six months after the sputum became offensive, the lower lobe of the left lung was removed in one stage under cyclopropane anesthesia. A posterior oblique incision was made, beginning from the second rib close to the spine, extending to the eighth rib, and curving to the posterior axillary line. The fourth rib was resected and ¼ inch of the third, fifth, sixth, seventh, and eighth ribs was removed about 1 inch from the articulations with the spine. Opening the pleural cavity revealed only a few adhesions binding the lung to the diaphragm. A mass ligature of braided silk was used to ligate the pedicle. The stump of the bronchus was carbolized and the branches of the pulmonary arteries and veins were separately ligated with chromic catgut. A flapper drainage tube was inserted into the eighth interspace. The patient received 500 c.c. of blood during the operation. Positive pressure was maintained during the closure of the chest and during the time the patient was being transported to her bed and placed under the oxygen tent.

There was no postoperative reaction of any consequence. The value of the oxygen tent was appreciated when the oxygen was temporarily discontinued to permit dressing of the wound. The patient became cyanotic and dyspneic. After several days the tent and drainage tube were gradually discontinued. The expectoration became less and in about six weeks it had entirely ceased. The pathologic report showed chronic interstitial pneumonitis, chronic bronchitis and bronchiectasis. (Fig. 7.) Radiographic examination on April 18, 1939 showed the left upper lobe expanded to the chest wall and the parenchyma well illuminated. (Fig. 8.) There

was slight increased contraction of the left hemithorax and slightly increased bone regeneration at the severed ribs.

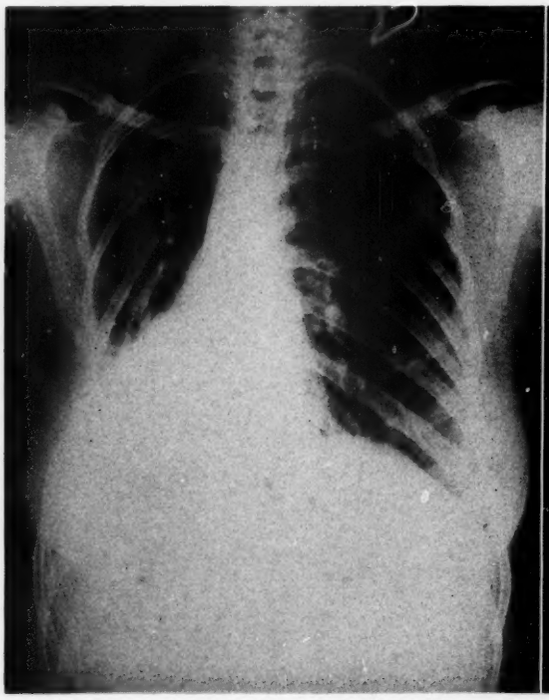


FIG. 8. Case 11. April 18, 1939. The left upper lobe expanded to the chest wall and the parenchyma well illuminated. There is increased contraction of the left hemithorax and slightly increased bone regeneration at the severed ribs.

FIG. 9. Case 11. June 12, 1939, one year after removal of the left lower lobe.

After one year the patient could walk three flights of stairs to her apartment without becoming distressed. She did not cough or expectorate and had gained considerable weight. (Fig. 9.)

COMMENT

The Trendelenburg position was employed before the operations for postural drainage and to accustom the patient to lie on the side of the unaffected lung in the position to be assumed during the operation and during the immediate postoperative state.

Pneumothorax was not employed in either patient. In the first patient the numerous pleural adhesions resulting from the empyema precluded such a procedure. The advisability of preoperative collapse was considered in the second patient with the object of immobilizing the mediastinum and permitting the right lung to make compensatory readjustment in breathing and thus reduce the assault to the cardiorespiratory apparatus. However, pneumothorax was not attempted for two reasons: (1) because with the existence of a profuse foul mucopurulent expectoration there was the possibility of compressing the bronchus and impeding drainage; and (2) because the bronchogram revealed that the disease had extended to the periphery of the lung, which, if injured, might have initiated an empyema.

Kalb[18] claims that pneumothorax is not an innocuous procedure. He has observed that 60 to 80 per cent of tubercular patients develop pleurisy with effusion and 16 per cent develop empyema after pneumothorax.

As anesthesia, avertin, nitrous oxide and oxygen were used in the first case and cyclopropane in the second. Positive pressure was maintained at the completion of both operations until the patients were transported to the ward and placed in oxygen tents.

Cyclopropane is undoubtedly a very desirable anesthetic as only minimal anox-

emia is possible. Intratracheal anesthesia was not employed, since satisfactory control of the expansion of the remaining lobes was efficiently maintained by the pressure in the rebreathing bag with the use of a snugly fitting face mask. Intratracheal suction was not found necessary in either case although the anesthetist was prepared for it should it have been found advisable.

In both cases the approach was through a posterior incision in the sixth interspace, as recommended by Lilienthal. In the first case because of the previous operations for empyema, the fused fifth and sixth ribs were resected. This approach gave easy access to the right lower lobe which was firmly adherent to the chest wall and diaphragm. In the second case the posterior incision began at the second rib 2 inches lateral to the spinous process, extended down to the eighth rib, then curved obliquely outward to the posterior axillary line. The fourth rib was resected and one-quarter of the third, fifth, sixth, seventh, and eighth ribs was removed. This exposure was more than ample and greatly facilitated the operation.

The pedicle of the hilum was ligated in both cases by mass ligature with braided silk. The bronchus and branches of the pulmonary artery and vein were then ligated separately with No. 3 chromic sutures. In the first case the silk ligatures were left long and the ends projected through the drainage wound, but ultimately had to be removed.

In the first case two rubber tube drains were used through a small wound in the sixth interspace because of the amount of previous pleural infection. In the second case a small Lilienthal flapper tube was inserted in the eighth interspace. Both patients developed low grades of empyema, though the extent of the infection in the second case was slight.

Both patients were transfused after the operation and the second patient was placed immediately in an oxygen tent even though her condition was satisfactory at the completion of the operation. The advantages of the oxygen tent in diminishing anoxemia and increased comfort to the patient following pulmonary operations cannot be over estimated.

CONCLUSIONS

Two cases of lobectomy for bronchiectasis are reported. One patient showed evidence of sepsis associated with a lung abscess following pneumonia and empyema. She has been followed for five years and has had a normal pregnancy since her lobectomy. The other had a simple and nonputrid bronchiectasis for seventeen years until six months before admission, when evidence of putrid changes ensued. She has been entirely free of symptoms since the removal of her left lower lobe over one year ago.

The results of surgery for bronchiectasis are conceded to be the best in the simple, nonputrid group. Cognizance of this statement must be taken in order to effect a reduction in mortality with radical surgery for bronchiectasis. It is admittedly difficult for the clinician, because of the reported high mortality of lobectomy for bronchiectasis, to abandon conservative therapy even though he has exhausted every other method of treatment. Nevertheless, he must distinguish between the simple nonputrid, the septic, and the putrid groups, because the risk of surgical intervention is different for each. The relatively low mortality for lobectomy in nonputrid cases of bronchiectasis should be an impetus to the physician to refer this group for surgery before some intercurrent infection activates the disease into the septic or putrid stage. It is gratifying to note that the mortality in each group has appreciably lessened in recent years because of the superior preoperative preparation, better anesthetic agents and their more effective administration, the judicious choice of the one- or two-stage operative procedure and improved postoperative care, all manifestations of the development of better coöperative effort in the management of a precarious undertaking which

offers the only permanent relief from a disabling disease.

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PERIPHERAL ARTERIAL EMBOLISM*

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PERIPHERAL arterial embolism occurs with sufficient frequency in the large general hospital to warrant special interest in its diagnosis and treatment. These cases offer a perplexing problem to the surgeon as their condition is often too poor to warrant radical therapeutic measures, and conservative methods too often are unsuccessful. In an attempt to evaluate the result of therapy, the records of twenty-five patients treated at the Cook County Hospital during the years from 1928 to 1938 were reviewed. This by no means represents all the cases, as many have been filed under other diagnoses or have remained unrecognized. It is also probable that there have been spontaneous cures through the establishment of collateral circulation.

ETIOLOGY

Peripheral arterial embolism strikes with almost equal frequency in males and females. In our series there were eleven males and fourteen females. Although the patients may be of any age from childhood to old age, most of the cases occur in late adult life. In our series there were two patients under 10 years and two patients between 70 and 80 years. (Table 1.) The largest number, however, occurred in the sixth decade, and the average age was 42 years. There does not appear to be any racial predisposition to the disease. In our cases seven of twenty-five patients were colored. This approximately parallels the general admission ratio of the hospital.

TABLE 1
AGES BY DECADES

Age	1–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79
Cases	2	0	4	3	5	3	6	2

As is usually observed, mitral heart disease, on the basis of subacute bacterial or chronic rheumatic carditis, is the direct etiologic agent. Nine of our patients had rheumatic heart disease, and five others were diagnosed as either malignant or subacute bacterial endocarditis.

In thirteen of our cases there was active fibrillation at the time of the embolism; five were being digitalized.

Seven of the twenty-five patients had chronic myocarditis with definite arteriosclerotic changes.

In none of this series was diabetes present, nor was there any factor suggesting previous pulmonary infarction, although three patients met death with terminal pulmonary emboli. (Fig. 1.)

The lower extremities are more frequently involved than the upper. Only five of our twenty-five cases were in the upper extremity. Petit-Pierre graphically represented the usual sites of embolism. (Fig. 3.) We have listed the percentages of this series with his classical representation.

TREATMENT

The treatment of arterial embolism is divided into four types: non-operative; arteriotomic operations; arterectomic; and

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amputative operations. Most of the reports in the literature concern themselves solely with the results of embolectomy.

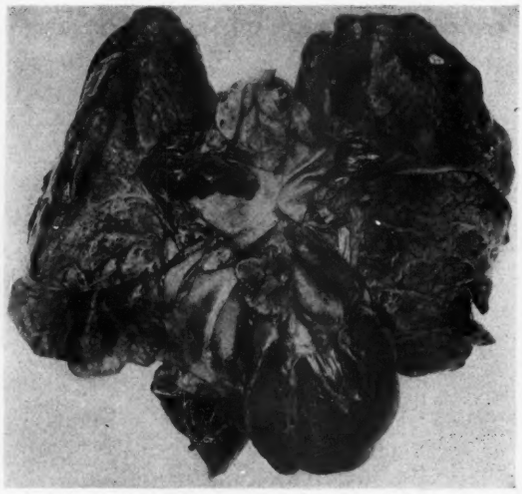

Fig. 1. The pulmonary embolus of Case xiv.

Conservative therapy aims to (1) release the concomitant vasospasm; (2) improve collateral circulation; (3) relieve pain. Only a small percentage of cases survive conservative measures without going on to amputation. Because many are old and debilitated individuals with poor circulatory efficiency and reserve or with previous vascular occlusions in the extremity, conservative therapy is the only method possible.

An embolism to the upper extremity can usually be treated conservatively because the collateral circulation will furnish sufficient blood to the limb.[19] The patient should be kept in bed with the extremity flat or slightly dependent. General supportive measures should be carried out as indicated. Antispasmodic drugs, such as papaverine hydrochloride, gr. ½, given intravenously every four hours, or sodium nitrite gr. 1 every two hours, have proved very helpful.[24] The use of hypertonic salt solution (5 per cent, 200 c.c. intravenously) is valuable.[11] The positive and negative pressure boot and intermittent venous compression have yielded excellent results.[25]

Embolism of any large vessel in the lower extremity down to and including the popliteal arteries is a surgical emergency and should be treated as such at once without any hopeful procrastination. This is especially true of a saddle embolus at the aortic bifurcation. One should not wait once the diagnosis and site of lodgement of the embolus are reasonably certain.[2] Pearse,[23] de Takats,[21] and others have shown the importance of this time factor, ten hours, in the performance of an embolectomy. If this time is exceeded, reformation of a thrombus at the site where the embolus has impinged becomes an added risk to embolectomy. (Fig. 2.) Propagating thrombi in the large veins of the calf muscles may be anticipated.[2] The final cause of death is usually subsequent embolic phenomena in many of these cases.[9]

Fig. 2. Fig. 2a.

Fig. 2. Reformation of the thrombus at the aortic bifurcation following operation (Case xiv).

Fig. 2a. The intimal suture line after removal of the clot (Case xiv).

As to the operation itself, spinal anesthesia is used in preference to general anesthesia because of the maximum vasodilatation obtained.

If it is found impossible to secure a free flow of blood after the embolus is removed, it is best to remove a segment of the artery

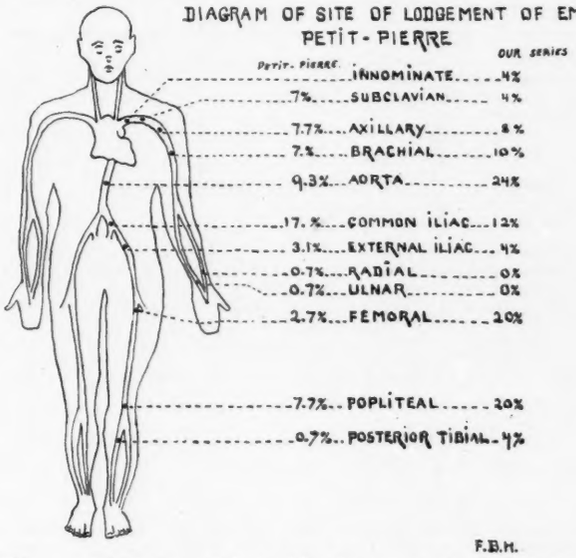

FIG. 3. Diagram of site of lodgement of emboli (Petit-Pierre as compared to our series).

(arterectomy), according to Leriche and Fontaine,[27] thus removing the irritable focus of the vasospastic reflex and facilitating collateral circulation.

DISCUSSION

The reader may gather the impression that the above series has done little to add to the general knowledge of the therapy of peripheral embolism except to cast an air of pessimism upon any attempts at therapy. We do not believe this to be true. We have learned one important fact from the review of the clinical histories. This is that the usual case follows a more or less typical course towards a fatal termination, and that we can alter this course. The patient suffers the arterial accident and is brought to the hospital in poor general condition. Conservative methods are employed, as have already been discussed, and the patient then seems to rally and appear to be in a much better condition. Meanwhile the extremity becomes gangrenous and a partial demarcation of the gangrenous area takes place. As the patient improves he is kept on this conservative management for days or even weeks, appearing constantly to improve. Then there is a general increase in the toxemia. The fever rises, the pulse accelerates, and a moderate leucocytosis give evidence of this toxemia. As this increases, the alarm of the attendants becomes acute, and at last the emergency guillotine amputation is performed. This is followed by shock, infection, and death.

In cases in which amputation was done as soon as signs of improvement were apparent, the results were better. These amputations were far better borne and could be carried out as planned, elective procedures.

PROGNOSIS

The prognosis of arterial embolism is usually discussed as though success or failure of therapeutic measures depended on whether or not the extremity was saved. Less frequently does one find a discussion of the life outlook of the patient who has suffered the acute arterial accident. Both are, of course, important. In this review the strikingly high general mortality has been significant. We believe that this is due to several factors which are not common to all series of cases. These patients were observed in a large general hospital and the diagnoses were the primary ones. In other words, many other cases of arterial embolism have occurred in the time period cov-

TABLE

No.	Name	Age	Sex	Color	Clinical Diagnosis	Duration of Illness	Site of Embolus	Blood Pressure	Clinical Picture
1	C. T.	36	M.	White	Ulcerative colitis; coronary occlusion with mural infarction.	10 days Recent	Left axillary artery	120/80	Four days after admission patient suddenly developed severe pain in left arm, loss of warmth and sensation, pallor, and then blueness from elbow down. Symptoms gradually cleared up; five days later soft systolic murmur heard. On tenth day after onset of embolus complete return of temperature, sensation and motion. Pulse, however, not palpable at left wrist.
2	A. M.	65	F.	Negro	Ulcerative endocarditis; auricular fibrillation	15 years	Left axillary artery	126/60	History of weakness and shortness of breath for 15 years with swelling of ankles of 3 years, cough, loss of 30 pounds weight in past 2 or 3 months. Had at one time been in tuberculosis sanitarium; history of six miscarriages. On admission she was found to have shrill musical systolic murmur, bilateral fibroid, tuberculosis, extrasystole and mitral regurgitation. Suddenly developed pain, discoloration of left hand, inability to move left forearm; petechial showers with progressive downhill course.
3	G. D.	21	F.	Negro	Rheumatic endocarditis.	15 years	Left subclavian and right internal carotid	140/50	Patient had rheumatism at ages of 8 and 13, and 6 weeks before admission; paralysis of right side, aphonia 4 weeks; pain in right shoulder and elbow for 2 months. Upon admission: blowing systolic murmur with absence of pulse in left arm; left arm cold, blue and discolored—dry gangrene.
4	O. N.	58	M.	White	Coronary sclerosis.	4 months	Right innominate artery	Right—100/? Left—120/10	Four years before had flu; 4 months before was in bed with cough, expectorated blood. Four days after admission patient developed sudden numbness of right arm with absence of right radial pulse; arm became cold, cyanotic, brachial pulse disappeared; one week later entire right arm was dry and gangrenous.
5	H. B.	26	M.	White	Chronic rheumatic fever with partial cardiac decompensation; auricular fibrillation.	12 years 5 days	Right femoral artery; possible riding embolus slipping down one side	120/70	Complaints of weakness, vomiting, lumbar and epigastric pain, with dyspnea, swelling of ankles for 5 days before admission; sudden onset of severe cramps in both legs; right leg became cold, pulseless and in 3 days purple and mottled.
6	M. L.	62	F.	White	Chronic myocarditis with arteriosclerosis; chronic constipation.	12 years 6 months	Right femoral artery	144/90	Two days after admission complained of numbness, tingling and inability to move right leg; no pulsations felt above Poupart's ligament; foot became black.
7	E. L.	65	M.	White	Rheumatic myocarditis; slow auricular fibrillation.	14 years 6 months	Right femoral artery just below profunda	178/110	Sudden severe pain in right heel, developing coldness and blueness of foot with loss of sensation; sharp, stabbing, shooting pains extending above knee; cyanosis and coldness of lower leg; absent pulses.
8	A. D.	79	F.	White	Chronic myocarditis with auricular fibrillation.	10 years 6 months	Right femoral artery below profundus	250/114	Patient out walking 5 days before admission when she was suddenly seized by sharp, crampy pain in right knee which traveled down leg into foot. On admission: right leg appeared cyanotic and cold below knee; no palpable popliteal, dorsalis pedis or posttibial pulses on right side.
9	J. G.	49	M.	White	Chronic rheumatic endocarditis.	Several years	Left femoral artery	.....	Three weeks before admission patient, while walking, developed severe cramp-like pain in back of left leg; by night leg was discolored. This cleared up; 4 days before admission to hospital pain again sudden and severe in left lower leg; purplish discoloration and mottling from middle of leg to ankle with loss of tactile and position sense; hyperesthesia to middle of leg posteriorly; no palpable dorsalis pedis or posterior tibial. Left foot cold. Temperature 103.2; blowing systolic murmur. Gangrene with blue toes and heel of left leg 8 days after onset.

I

Operation	Time between Occurence of Embolus and Operation	Postembolic Complications	Outcome	Essential Pathologic Findings (If Available)	Miscellaneous
.....	.....	Very mild atrophy of muscles of forearm.	Return of function.		
.....	.....	Coma and glomerulonephritis.	Died 15 days after admission, 10 days after embolic phenomenon.	Embolic occlusion of left axillary artery with dry gangrene of left forearm; thrombo-ulcerative endocarditis of mitral valve; myocardial degeneration; acute hemorrhagic glomerulonephritis.	
.....	.....	.....	Died 3 days after admission; 4 weeks after onset.	Malignant vegetative endocarditis of mitral valve with mural embolic occlusion of left subclavian and right internal carotid artery.	
.....	.....	Multiple lung infarcts.	Died 10 days after embolism, 2 weeks after admission.	Clot in the innominate covering right subclavian artery; pulmonary infarction; coronary sclerosis.	
Amputation of right leg above knee	24 days	Possible bacterial endocarditis, although blood culture was negative.	Fair.	Popliteal artery in amputated leg contained firm clot.	Had digitalis on admission.
Embolectomy	5 hours	Probable pulmonary embolus.	Death 10 hours later.	No post-mortem examination.	Pulse not palpable after embolectomy.
Amputation of right leg, middle thigh	12 days	Possible cerebral shower of emboli (irrational).	Good.	.....	Had digitalis on admission.
.....	.....	.....	Died 2 days after admission, 7 days after onset.		
Midthigh amputation	15 days	Purulent infection of stump; peritonitis; uremia.	Died 24 days after onset, 9 days after amputation.	Arteriosclerotic gangrene with thrombosis of posterior tibial artery.	May be question whether this is a thrombosis.

TABLE I

No.	Name	Age	Sex	Color	Clinical Diagnosis	Duration of Illness	Site of Embolus	Blood Pressure	Clinical Picture
10	P. Y.	55	M.	White	Auricular fibrillation.	6 years	Saddle embolus (aortic bifurcation)	.....	Sudden severe bilateral pain, numbness and cold developing in both legs, with purplish discoloration of both feet; right leg popliteal circulation returned; pulses absent in feet.
11	M. L.	62	F.	Negro	Decompensation with chronic myocarditis.	1 year	Saddle embolism of aorta	140/100	Patient entered hospital shortly after onset of sudden numbness without pain, paralysis, tingling of both legs, duration 1 hour. Physical examination: no murmurs; pulse irregular, pallor, coldness of both legs and thighs; went on to mottled discoloration with absence of sensation, paralysis, loss of tendon reflexes; no dorsalis pedis or popliteal pulse in either leg; patient stuporous.
12	A. R.	26	F.	Negro	Malignant endocarditis; self-induced abortion.	2⅓ weeks 3 weeks	Saddle embolus; (aortic bifurcation)	.....	History of numerous self-induced abortions; three weeks before entrance had performed another abortion, followed in 3 days by general muscular aches and pains and temperature. Three days before admission developed a delirium; at admission both legs markedly edematous and cold with beginning discoloration.
13	L. B.	38	F.	White	Auricular fibrillation with rheumatic myocarditis.	6 months	Saddle embolus (aortic bifurcation)	.....	Six months before, patient had a stroke with right sided hemiplegia. Thrill, systolic, diastolic murmur; auricular fibrillation on admission. Lower third of left leg discolored and colder than right; popliteal, femoral and dorsalis pedis pulses not palpable in either leg. Embolectomy considered but general condition poor; gangrene and discoloration were progressive.
14	W. C.	52	M.	White	Chronic myocarditis; auricular fibrillation (old heart disease). Saddle embolus at aortic bifurcation.	30 years 3 hours	Saddle embolus (aortic bifurcation)	.....	Good health but for a longstanding heart disease; fairly well compensated; awoke suddenly one morning and found himself unable to use either lower leg; legs became cold and blue. Entered hospital 3 hours later; both limbs blue, cadaveric and cold; no pulsations of femoral or external iliac felt.
15	A. S.	47	F.	White	Chronic myocarditis with auricular fibrillation.	2 years	At aortic bifurcation and into left common iliac	160/118	Sudden severe crampy pain in both legs while lying in bed. On admission, right leg cold and blue to midthigh with no dorsalis pedis, posterior tibial or popliteal pulse and no oscillometric fluctuations in either leg. Entire left leg cold and blue to hip. Transperitoneal approach to aortic bifurcation.
16	E. A.	9	M.	Negro	Subacute bacterial endocarditis.	5 months	Right common and left common iliac	.....	Had rheumatism 5 months before admission; 5 days before admission had cough, fever, headache, aphonia, repeated vomiting attacks developed blueness, edema, coldness of both lower legs. On admission temperature 101, blowing systolic murmur, friction rub, petechial crops and marked cardiac enlargement.
17	J. B.	40	M.	Negro	Malignant endocarditis.	10 years	Right common iliac artery	130/50	Had rheumatism 10 years before; for the past 3 weeks chills, fever, dyspnea, palpitation, heart consciousness, cough, nocturia. On admission double murmur at apex, rough aortic second with Durozieg's sign and Corrigan and capillary pulse. Negative Kahn; blood culture repeatedly positive for *S. hemolyticus*. Progressive downhill course. Right leg suddenly became cold and numb and went on to dry gangrene.
18	L. R.	24	F.	White	Malignant endocarditis.	3 weeks	Right external iliac artery	92/9	Developed a cold 3 weeks before; backache, fever and chills for 10 days; loud apical systolic murmur. Blood culture positive for *S. viridans*. Sudden onset of pain and coldness of right leg. Pulses gone in a cold blue extremity.

(*Continued*)

Operation	Time between Occurence of Embolus and Operation	Postembolic Complications	Outcome	Essential Pathologic Findings (If Available)	Miscellaneous
Amputation of left leg	14 days	Pulsus deficit.	Died 28 days after amputation; cardiac death.	No post-mortem examination.	
.....	.....	Coma	Died 48 hours after onset.	Embolism of both femoral arteries.	
.....	.....	Hemorrhagic encephalitis.	Died 3 weeks after abortion, 3 hours after admission.	Acute hemorrhagic leucocytic encephalitis; parenchymatous degeneration of myocardium; gray firm mass which straddled bifurcation of aorta.	
.....	.....	.....	Died 8 days after onset.	Embolic occlusion of lower aorta with secondary thrombosis of iliac and femoral arteries; mitral deformity and stenosis; mural thrombus in left ventricle and dry gangrene, both legs.	
Transabdominal approach with aortic embolectomy	6 hours	Pulmonary embolism.	Died 48 hours after onset, 42 hours after surgery.	Embolic occlusion of right main pulmonary artery; thrombosis of abdominal aorta; fibroplastic mitral deformity; cardiac dilatation; beginning gangrene of both legs.	Had digitalis on admission.
Embolectomy pulse returned in left leg	6 hours	.....	Died 36 hours after operation.		
.....	.....	Bronchopneumonia and acute glomerulonephritis.	Died 11 days after admission, 6 weeks from onset of last attack.	Thrombo-endocarditis of mitral valve; multiple abscesses of myocardium; anemic infarcts and abscesses of spleen and kidneys; acute glomerulonephritis and bronchopneumonia; embolic aneurysm of right common iliac; embolic thrombotic occlusion of common iliac.	
.....	.....	Septicemia.	Died 3 days after admission, 3 weeks after onset of acute exacerbation, 14 days after onset of embolus.	Malignant endocarditis of mitral and aortic valves with old fibroplastic deformity; fibrinous pericarditis; mycotic emboli to kidneys; embolus to right iliac artery with dry gangrene of right leg.	
.....	.....	Septicemia.	Died 18 hours after admission, 10 days after onset of embolus.	Acute malignant endocarditis of mitral with focal interstitial myocarditis; external iliac occluded just beyond opening, hypogastric artery.	

TABLE I

No.	Name	Age	Sex	Color	Clinical Diagnosis	Duration of Illness	Site of Embolus	Blood Pressure	Clinical Picture
19	J. M.	74	F.	White	Chronic myocarditis with auricular fibrillation.	Several years	Right common iliac artery	100/70	Patient had rheumatism for a number of years; on day of admission she experienced sudden pain in right leg and inability to move this leg. Leg progressed to extensive dry gangrenous changes; heart rate rapid with poor tones.
20	M. S.	63	F.	White	Chronic myocarditis with large heart and mitral regurgitation.	12 years	Left popliteal artery	.....	Five days before admission experienced sudden cramping pain in the left lower leg. Leg went on to coldness, numbness. Left femoral palpable but left popliteal absent as was left dorsalis pedis. Poor condition prevented amputation.
21	P. N.	63	M.	Negro	Arteriosclerosis with chronic myocarditis.	4 years	Left popliteal artery	.....	Four years before admission had a similar acute attack of pain in right leg which resulted in amputation. Two days after onset of an intermittent sticking pain in left leg, suddenly developed severe continued pain in this leg and entered hospital. No palpable left popliteal or dorsalis pedis; 8 days after onset toes were gangrenous, ankle and foot discolored, and demarcation was being established. (Sixteen days after-onset blood pressure suddenly dropped to 72/52.)
22	M. U.	38	F.	White	Rheumatic heart disease with fibrillation.	Chronic	Popliteal bifurcation in left leg	.....	Admitted with 2 hour history of pain, cramp-like and excruciating, up to middle third of thigh. Patient had been bedridden for some time. On admission temperature 96. Tachycardia and fibrillation, loss of function of foot, coldness to popliteal space and discoloration of foot. Both femoral pulsations poor; faint posterior tibial pulsation in the good leg, no demarcation.
23	M. L.	4	F.	White	Rheumatic endocarditis with auricular fibrillation.	7 weeks	Bilateral popliteal arteries	150/100	Patient developed cold 7 weeks prior to admission; 4 weeks before sudden severe pain in left leg below knee. Knee began to swell, blisters and blackened areas of discoloration appeared on leg and foot. Both legs then became cold, swollen and tender and left foot necrotic. On admission she was markedly dyspneic on exertion with no palpable dorsalis pedis of left foot.
24	J. M.	44	M.	White	Old rheumatic heart disease and auricular fibrillation.	8 years	Bilateral popliteal arteries	130/82	Shortness of breath for 8 years; entered hospital with irregular pulse fibrillating; put on digitalis; 18 days after admission left leg became suddenly cold and blue; on the twentieth day both legs became blue and by the twenty-third day they were covered with blebs.
25	C. L.	48	F.	White	Auricular fibrillation.	3 months	Right leg posterior tibial artery	130/70	Sudden onset of pain in right leg to knee and toes with tenderness in right popliteal space; loss of pulsation, heat, color, function and sensation in right foot; developed a gangrene of right foot; toes sloughed four months after onset.

ered, but the records have been filed under other headings. Thus, many of these records were located by searching necropsy reports. In others the embolism was the terminal factor and, therefore, received special attention. It is for this reason that the general mortality percentage is unusually high.

The mortality of the disease is, however, very high for several reasons. Arterial embolism is usually but one of the complications or sequelae of some other systemic disease, which of itself bears a high mortality rate. If a person has an arterial embolism to the femoral artery, he may very well have others to the brain or other vital

(Continued)

Operation	Time between Occurence of Embolus and Operation	Postembolic Complications	Outcome	Essential Pathologic Findings (If Available)	Miscellaneous
.....	.....	Pulmonary embolism.	Died 9 days after onset.	Mural thrombi in auricles; hypertrophied heart with parenchymatous degeneration of myocardium; embolic occlusion-right common iliac; pulmonary embolus.	
.....	.....	.....	Died 16 days after onset; cardiac death.	.....	Had digitalis on admission.
Amputation of left leg just above knee	20 days	.....	Died 20 days after onset and 6 hours after amputation.	Arteriosclerotic aneurysm of popliteal with embolus to popliteal artery.	
.....	.....	Spreading cellulitis and gangrene.	Died 59 days after onset, cardiac plus sepsis.		
Bilateral amputation, mid-calf	4 weeks	Embolic occlusion of superior mesenteric artery.	Died 5 months after admission, 6 months after onset.	Fibroplastic deformity of mitral valve with ball-valve thrombus in left auricle; occlusion of superior mesenteric artery and gangrene of upper jejunum; embolic occlusion of both popliteal arteries.	
.....	.....	Sepsis.	Died 42 days after onset.	.....	Digitalis.
.....	.....	None.	Home; loss of toes of right foot.	.....	Had digitalis on admission.

center. As most of these occurred in patients of advanced years, one must consider all of the dangers which beset senility, hypostasis, myocardial disease, etc. Others occurred in patients with severely damaged hearts who were unable to bear the brunt of a gangrenous toxemia.

The prognosis for the saving of the limb is equally poor. There were too few cases in this series to pass judgment on the results of embolectomy. Other authors have, however, demonstrated its value in the early hours of the catastrophe.[14,15] In this series, the conservative measures have not been

very efficacious. This may be accounted for by the poor general status of the patients, and the fact that almost all of them had emboli in the larger vessels. As has been said, it is probable that a more complete picture of the value of conservative measures might be gleaned from a more complete series. (Table III.)

TABLE II
ETIOLOGIC OR CONCURRENT DISEASES

Disease	Cases
Ulcerative colitis	1
Coronary occlusion	2
Rheumatic heart disease	9
Arteriosclerosis	7
Chronic myocarditis	7
Ulcerative and malignant endocarditis	5

We again repeat our preference for the Callendar tenoplastic amputation, or disarticulation of the knee joint, as few fascial spaces are then opened. Subdural infiltration as previously stated is our method of choice for anesthesia.

TABLE III
RESULTS

Treatment	Average Life Duration from Onset	Cases	Case Mortality	Percentage Mortality
Embolectomy	39 hours	3	3	100
Amputation	47 days	6	4	66
Conservative	20 days	16	14	88

CONCLUSIONS

Acute arterial embolism of the extremities is a complication of other disease. It therefore adds the mortality of the embolism to the mortality of the preëxisting lesion. Embolectomy should be carried out in favorable cases, within six hours of the onset. Conservative measures may be of benefit and may save the extremity as there is a diffuse vasospasm accompanying the lodgement of the embolus. Amputation must, however, be done in a large percentage of the cases.

There is a "time of election" for the amputation, viz., when the patient's general status has been improved, and before the toxemia has developed. An amputation which does not open up new fascial spaces is one of choice.

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Pathologic conditions of the arteries will be recognized by the uneven or moth-eaten appearance of the vessel walls. Their course may be wavy and irregular; they may end abruptly.
From—"Peripheral Vascular Diseases" by Kramer (Blakiston).

A CLOSED CITRATE METHOD OF COLLECTING BLOOD*

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MEMPHIS, TENNESSEE

A PRACTICAL and relatively inexpensive method of collecting blood for citrate transfusion has been developed at the "blood bank" of the John Gaston Hospital. This method has proved satisfactory in the hands of different members of the house staff who have used it for the collection of more than 2,500 flasks of blood. A description of the equipment and technique is warranted because modifications not in common use are included and because unnecessary surgical preparatory procedures and mechanical suction devices have been eliminated.

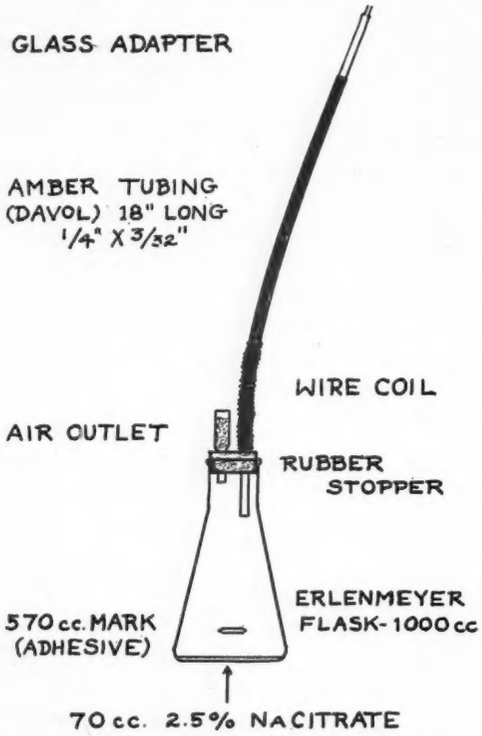

FIG. 1. The taking set.

Equipment. (Figs. 1 and 2.) The taking set consists of the following parts:

1. Erlenmeyer flask, 1,000 c.c. of resistance glass or of pyrex, with adhesive market at 570 c.c. point.
2. Two-hole rubber stopper, No. 9.
3. Inlet tube, glass, bore $\frac{3}{16}$ inch, length 6 inches.
4. Rubber tubing, transparent, Davol, bore $\frac{1}{4}$ inch, wall $\frac{3}{32}$ inch, length 18 inches.
5. Spring wire coil, made by bending 3 feet of No. 18 brass wire around a stick.
6. Needle adapter, all glass, or glass with luer-lock attachment.
7. Outlet tube, glass with absorbent cotton filter.
8. Cloth bag with two dry test tubes containing cork stoppers.
9. Sodium citrate, reagent grade (Merck), 70 c.c. of 2.5 per cent in freshly distilled water. The citrate is made up just before the taking set is assembled.

In assembling the set the citrate solution is measured in a small graduate and poured into the flask, the rubber stopper with its connections is placed in the mouth of the flask and the cotton bag with its test tubes is tied around the neck of the flask. A small square of gauze is placed around the glass adapter and held in place by a rubber band. The entire set is wrapped in a 24 × 24 inch piece of doubled unbleached domestic. The edges of the wrapper are fastened together with straight pins. The set is autoclaved for fifteen minutes at 15 pounds of pressure. Care is taken to sterilize the sets soon after they are assembled, so that the growth of organisms in the citrate solution and in the tubing is minimized.

The other parts of the equipment are sterilized in enamel surgical jars with lids. These are as follows:

1. Needles, straight stainless steel, gauge 16 to 17, length $1\frac{1}{2}$ inches. The needles are placed in test tubes with constricted sides and stoppered with cotton plugs. (Fig. 2.)

* From the Division of Medicine and Clinical Laboratories, University of Tennessee and John Gaston Hospital, Memphis, Tennessee.

The constrictions in the tubes catch the hub of the needle and thus protect the point. These tubes can be purchased from surgical supply houses, but they can be easily made by heating ordinary glass tubes over a gas flame and bending the sides in with a large hemostat.

2. Medicine glasses (for novocaine).

3. Cork stoppers. These are first covered with several layers of gauze, the corners of the gauze square being tied over the top of the cork. The covered cork is then wrapped in a paper and the paper held in place by a rubber band.

Novocaine, 1 per cent, is made up in sterile flasks. The hypodermic needle and syringes used in administering the novocaine are sterilized in an electric sterilizer.

Technique. The donor is placed on the examining table (Fig. 3), the sleeves rolled up and the arms inspected to determine the location of the best veins. The arm selected is placed in a dependent position on the sloping arm board. A blood pressure cuff is applied well above the bend of the elbow. The operator, using a sponge forceps, cleans the antecubital space with an iodine sponge and follows with an alcohol sponge. The assistant opens the taking set. Using sterile forceps, the assistant then removes from their respective surgical jars a medicine glass, a cork stopper and a constricted test tube containing a needle. These are placed on the inside cover of the taking set, thus avoiding the use of an extra sterile towel.

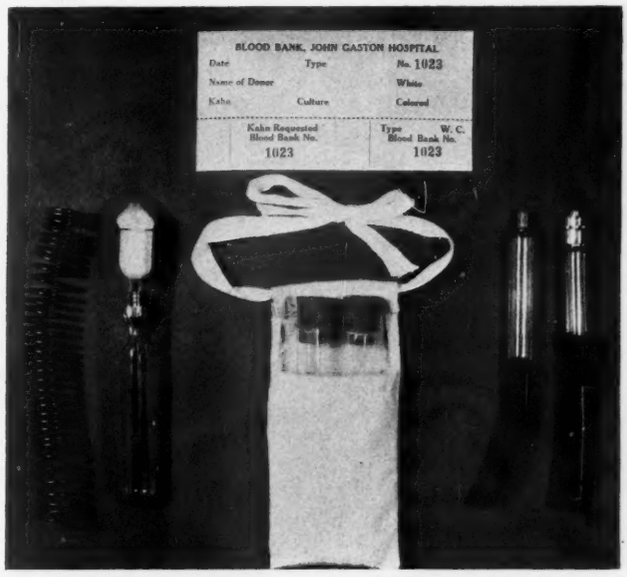

FIG. 2. Label with serial number for flask and with corresponding numbers for test tubes, spring wire coil, constricted test tube with needle, cotton bag with test tubes, adapters.

The assistant pours a few c.c. of sterile 1 per cent novocaine into the medicine glass, fills a sterile syringe, attaches the hypodermic needle and hands the syringe to the operator. The operator infiltrates the skin at the site of puncture. The assistant then takes off the cotton wrapper from the needle adapter and attaches the needle by pushing the adapter firmly down into the hub of the needle. The assistant then hands the adapter to the operator.

The operator inflates the blood pressure cuff to 60 to 80 mm. Hg. He fixes the skin below the site of puncture with one hand and performs the venipuncture with the other. (The hand should at no time touch the needle or the skin near the puncture site. Rubber gloves and sterile drapes are not used and not needed.) The assistant, seated on a low stool, holds the flask near the floor, so that the lower-most portion of the tube is several feet below the level of the donor's heart and the

FIG. 3. Taking table with sloping arm board.

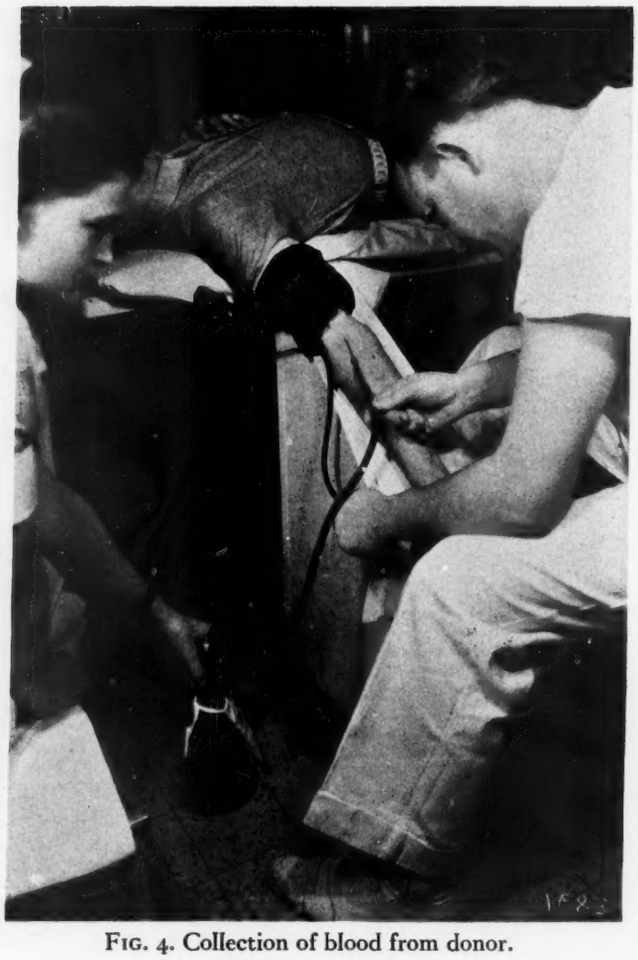

FIG. 4. Collection of blood from donor.

flow of blood is straight downward. (Fig. 4.) (The use of gravity suction in this manner makes mouth and mechanical suction devices unnecessary.) As the blood flows in, the assistant gently and continually rotates the flask to insure thorough mixture of the blood and citrate. It generally takes five to fifteen minutes to collect the blood. When the blood level reaches the 570 c.c. mark, the blood pressure cuff is released, the tubing is clamped above the spring wire with a hemostat and the needle withdrawn. The assistant takes the flask of citrated blood with its attached tubing while the operator applies pressure over the bleeding point with a gauze sponge and looks after the donor.

The assistant loosens the rubber stopper in the flask. The sterile cork is then unwrapped, care being taken not to touch the cork or the inside of the wrapper. The cork is held within the paper by grasping the knotted piece of gauze at the top of the stopper. The rubber stopper with its connections is now removed and the cork stopper substituted. The wrapping paper is bound around the neck of the flask with a rubber band.

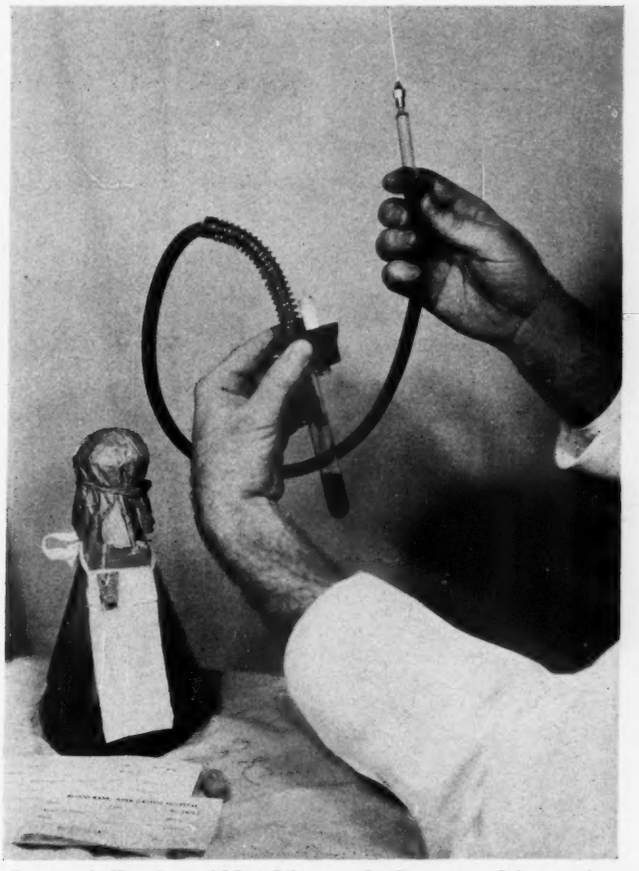

Fig. 5. Collection of blood for serologic test and for typing and cross matching.

The assistant takes one of the sterile tubes from the cotton bags and holds it beneath the glass inlet tube. The hemostat is loosened, and the blood in the tube is allowed to run into the test tube, the flow being controlled by raising and lowering the end of the tube or by compressing the tube. (Fig. 5.) The second tube is filled in the same manner. The clotted blood in one of the tubes is used for serologic tests and the blood in the other tube used for typing and cross matching. The flask is labelled with a gummed label bearing a serial number. Each test tube is labelled with a corre-

sponding number, thus minimizing the writing to be done and aiding in the identification of specimens. (Fig. 2.)

The flask with its test tubes is immediately placed in the refrigerator where it is stored at 4°C. until needed.

SUMMARY

A closed method for the collection of blood in citrate solution is described which has the following features:

1. The citrate solution is autoclaved in the taking flask.
2. Rubber gloves, sterile towels, towel clips, special needles, masks, and gowns are eliminated.
3. The blood is allowed to run downhill. Mechanical suction devices are eliminated.
4. A wire coil is used to protect the rubber tubing and to prevent kinking and occlusion of the lumen.
5. Needles are sterilized in test tubes with constricted sides.
6. The blood left in the tubing at the completion of the procedure is collected and utilized for serologic tests and for typing and cross matching.

VENOUS thromboses may be associated with, if not actually a reflex cause of, arterial spasm serious enough in some cases to induce gangrene of the limb.

From—"Circulatory Diseases of the Extremities" by Homans (Macmillan).

GLYCERIN OSMOTIC DRAINAGE

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THIS is a preliminary paper presenting the principles, and a few applications, of glycerin osmotherapy. A more complete statistical report, with particular reference to the use of the agent in abdominal surgery, is contemplated.

In the early days of physiologic surgery, Murphy[1] placed the limit of an abdominal drain's effectiveness at eighteen hours. Operators attempting to remove drains in accord with this dictum encountered disaster with such disconcerting frequency that even the dullest realized that drains must perform some unaccounted for function beyond the first postoperative day. It became apparent that drains do more than provide a conduit for inflammatory products, and prevent agglutination of the wound edges.

THE NATURE OF DRAINAGE

J. Shelton Horsley[2] clarified the biologic rôle of drains by showing that drainage material acts as an irritating foreign substance to induce a flow from the lymphatics in its vicinity. He pointed out that if the drainage material is a sufficient stimulus for the reversal of lymphatic circulation, so much lymph pours out that a practically continuous irrigation goes on along the tract of the drain, and that it is relatively unimportant whether the drain tract be up or down. Surgeons are daily witnesses, if not always comprehending ones, to this action of drainage material.

Reversal of lymphatic flow being the essential physiological element of drainage, any substance which evokes a flow of lymph is a drainage agent, whether it functions by irritation, as do mechanical drains, or by osmotic pressure, as do hypertonic solutions. A glycerin pack, used in conjunction with a mechanical drain, will markedly increase the amount of wound discharge over that induced by the mechanical drain alone. Any factor which contributes to the effectiveness of drainage makes recovery of the patient more probable and more rapid.

The polyhydric alcohol glycerin, $C_2H_5(OH)_3$, approaches the ideal as an accessory drainage agent.

SOME PROPERTIES OF GLYCERIN

Glycerin's osmotic action, by dehydrating wound tissues, contributes to healing, since edema impedes an adequate supply of phagocytic cells in the inflamed area, and edema by widening the lymph channels and increasing local tension favors dissemination of infection. A glycerin solution of 2.47 per cent is isosmotic with sodium chloride 0.85 per cent concentration, and the dehydrating effectiveness of stronger solutions is proportionate to the osmotic pressure of the glycerin solution compared to that of the tissue fluids. The osmotic principle of glycerin drainage is made clear by recognizing the glycerin-soaked cotton pack as a solute, the body tissue with which it comes in contact as a semipermeable membrane and the edema fluid of the inflamed area as a solvent. To secure the maximum osmotic action of glycerin it should be employed in full U. S. P. strength.

The hygroscopic possibilities of glycerin are shown by the Miner Laboratories in a graph which indicates the concentration of the substance in equilibrium with different relative humidities. The curve of this graph shows that at relative humidities higher than 15.5 per cent glycerin will absorb moisture until the equilibrium concentration is reached, and indicates that at humidites found in wounds the capacity of glycerin to absorb liquid discharges is almost incredible.

The toxicity of glycerin has been investigated by Johnson, Carlson and Johnson,[3]

who observed no adverse effects from its ingestion by human subjects or by laboratory animals. Previous reports of injurious

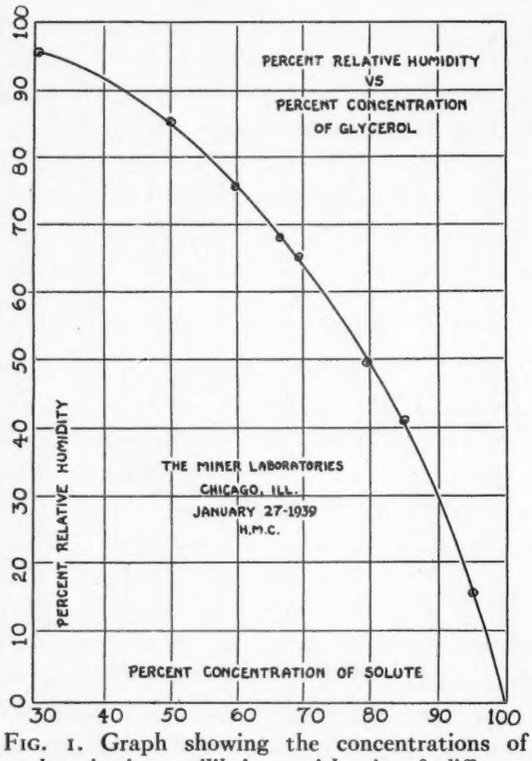

Fig. 1. Graph showing the concentrations of glycerin in equilibrium with air of different relative humidities.

consequences have been based essentially on instances of parenteral administration of glycerin. Rats showed normal growth and normal reproduction after forty weeks of a diet in which carbohydrates were replaced by glycerin to 41 per cent by weight of the total food intake. Fourteen human subjects, on an adequate diet, tended to increase in weight when 110 Gm. of glycerin per day were added over a period of fifty days.

The antiseptic and bactericidal action of glycerin was determined by Ruediger,[4] whose findings were confirmed by Compton.[5] (Table 1.)

Compton also proved that no staphylococci can survive a strength of 26.3 per cent glycerin, but that leucocytes tolerate concentrations up to 41.7 per cent, which fact places glycerin as an antiseptic in what he terms "the bacterial indifferent zone of cytobacterial activity." Glycerin's unusually favorable ratio of toxicity to bacteria and body cells is obviously of assistance in wound healing. The findings of Compton do not make it illogical to use full strength glycerin dressings for their maximum osmotic effect, since wound discharges promptly dilute the glycerin in immediate contact with the wound and protect the tissues from irritation.

Table 1

Organism	Antiseptic Response, Hours	Bactericidal Response, Hours
B. coli comm	15	18
B. coli	12	15
Staphylococcus	12	15
Strep. hemolyticus	6	8
Gonococcus	½	1

Many surgeons have unbounded confidence in the bactericidal action of dyestuffs, and if one cares to combine dyes with glycerin it will be found that mercurochrome 2 per cent, neutral acroflavin or gentian violet 1:1000, malachite green 1:500 and picric acid 1 per cent (by first dissolving the crystals, 1 grain to 1 c.c., in alcohol), and others are readily prepared. These glycerin-dye mixtures, in common with other bactericidal agents, are more effective when used hot since surface tension decreases with increasing temperature. Glycerin-dye mixtures of concentrations in Compton's favorable cytobacterial zone have been utilized in the treatment of a number of infections, Pleth[6] reporting excellent results in empyema, joint infections, and various urologic conditions.

SEVERAL USES OF OSMOTIC DRAINAGE

After the physiologic basis of drainage is understood, and one grasps the principles and methods of application of glycerin osmosis, opportunities to use glycerin drainage present themselves with surprising frequency.

Lichtenstein[7] and others have reported most satisfactory results following the use of glycerin as a dressing in traumatic surgery.

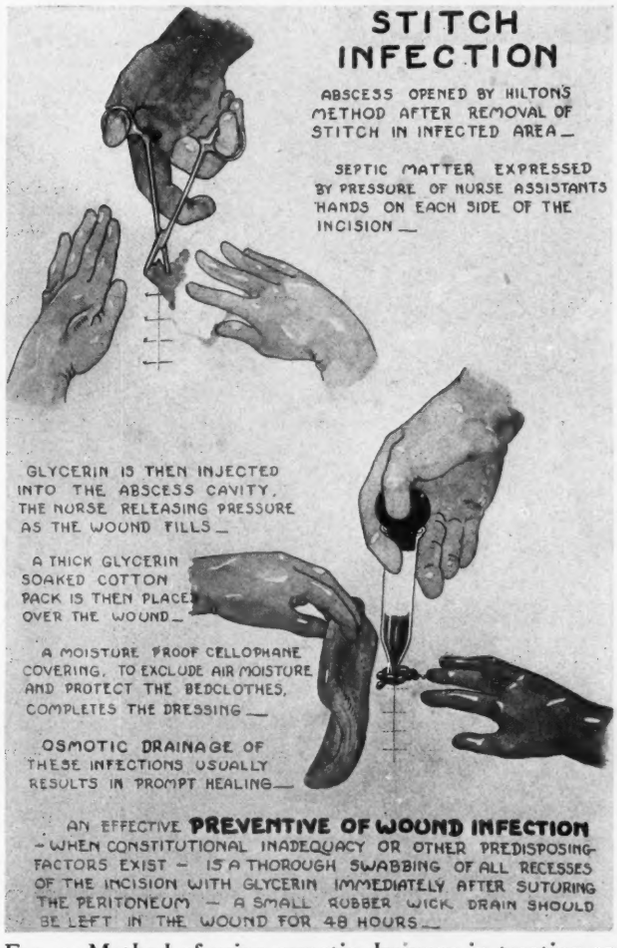
STITCH INFECTION
ABSCESS OPENED BY HILTON'S METHOD AFTER REMOVAL OF STITCH IN INFECTED AREA
SEPTIC MATTER EXPRESSED BY PRESSURE OF NURSE ASSISTANTS HANDS ON EACH SIDE OF THE INCISION
GLYCERIN IS THEN INJECTED INTO THE ABSCESS CAVITY, THE NURSE RELEASING PRESSURE AS THE WOUND FILLS
A THICK GLYCERIN SOAKED COTTON PACK IS THEN PLACED OVER THE WOUND
A MOISTURE PROOF CELLOPHANE COVERING, TO EXCLUDE AIR MOISTURE AND PROTECT THE BEDCLOTHES, COMPLETES THE DRESSING
OSMOTIC DRAINAGE OF THESE INFECTIONS USUALLY RESULTS IN PROMPT HEALING
AN EFFECTIVE PREVENTIVE OF WOUND INFECTION - WHEN CONSTITUTIONAL INADEQUACY OR OTHER PREDISPOSING FACTORS EXIST - IS A THOROUGH SWABBING OF ALL RECESSES OF THE INCISION WITH GLYCERIN IMMEDIATELY AFTER SUTURING THE PERITONEUM - A SMALL RUBBER WICK DRAIN SHOULD BE LEFT IN THE WOUND FOR 48 HOURS

Fig. 2. Method of using osmotic drainage in treating an abscess or a potentially infected wound.

In industrial injuries, in contusions, lacerations of muscles and tendons, and in potentially infected wounds, glycerin dressings have been found so effective that for ten years their use has been routine in our office and hospital emergency work, with the result that pus as a complication of traumatic surgery has all but disappeared. The method of use is quite simple. First, a layer of single thickness gauze is spread over the injury, or tucked into all recesses of the wound if its severity dictates delayed suture. Next, generous masses of long fiber cotton are soaked with 98 per cent glycerin and placed in and completely covering the wound. An outside covering of moisture-proof cellophane is then used to prevent hygroscopic absorbtion of atmospheric moisture and to protect the final bandage, the patient's clothing and bedding from being soaked with glycerin and evoked wound discharge. When glycerin packs are used within the abdomen, cotton is not considered safe, so gauze, which is less absorbent, or a special drain, is substituted. This type of dressing promotes freedom from tissue swelling and doubtless accounts for the comfort patients experience after even severe contusions and lacerations, and it unquestionably permits freer phagocytic and reparative function.

Even when wounds are seen after some delay, and infection has become established, glycerin packs may be expected to relieve lymphangitis, to prevent furun-

culosis—which has a tendency to develop with most wet dressings—to control the infection, and to change the pus discharge to serum within a surprisingly short time. In frankly infected wounds of muscles, hypochlorite solution may at times be preferable to glycerin, but in fresh wounds, before deep penetration of infection—where Dakin's solution may be harmful—prompt clean healing usually results from mechanical cleansing with carbon tetrachloride and tincture of green soap, followed by a glycerin douche into the depths of the wound with a generous glycerin-soaked dressing and a day or two of delay in suturing.

In a number of conditions, as in cases necessitating considerable blunt dissection, in cases with questionable constitutional adequacy of the patient, or when operations must be conducted in areas difficult to sterilize and to keep clean during healing, wound infection may be prevented by pouring a jigger of glycerin into the wound and smearing it into all crevices before suturing. Hernias, scrotal and gynecologic plastics, sacrococcygeal dermoids, fractured patellas and other orthopedic operations benefit from such treatment. Particularly in vaginal operations, as for example the Mayo operation for cystocele, packing the vagina loosely with glycerin-soaked gauze through a Kelly proctoscope at the conclusion of the operation results in less fluid tension in the tissue planes, greater comfort, and a lower incidence of infection.

We have treated a few cases of chronic osteomyelitis with a free flooding of glycerin, or glycerin with an antiseptic

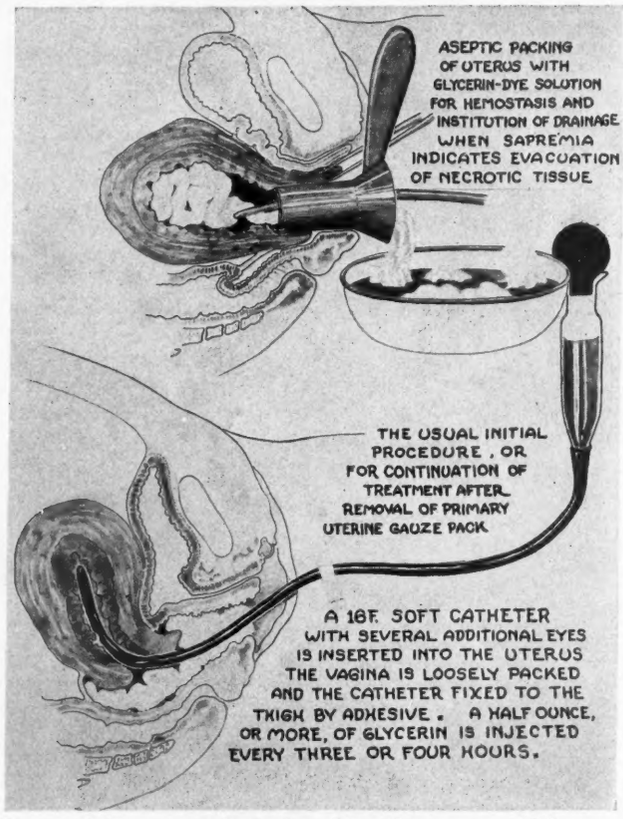
ASEPTIC PACKING OF UTERUS WITH GLYCERIN-DYE SOLUTION FOR HEMOSTASIS AND INSTITUTION OF DRAINAGE WHEN SAPREMIA INDICATES EVACUATION OF NECROTIC TISSUE
THE USUAL INITIAL PROCEDURE, OR FOR CONTINUATION OF TREATMENT AFTER REMOVAL OF PRIMARY UTERINE GAUZE PACK
A 16F. SOFT CATHETER WITH SEVERAL ADDITIONAL EYES IS INSERTED INTO THE UTERUS THE VAGINA IS LOOSELY PACKED AND THE CATHETER FIXED TO THE THIGH BY ADHESIVE. A HALF OUNCE, OR MORE, OF GLYCERIN IS INJECTED EVERY THREE OR FOUR HOURS.

Fig. 3. Above, a method of packing the uterus which prevents contamination of the gauze and facilitates introduction of the maximum amount of glycerin. Below, modified Remington-Hobbs method of using glycerin drainage in the septic uterus. A self-retaining catheter has proved to be more satisfactory than the style illustrated.

dye, and our impression is that healing was more rapid than following other forms of treatment.

In the cases of several extensive burns, which had developed infection and degrees of toxemia, and were unsuitable for treatment with tannic acid, prompt improvement resulted from the application of voluminous glycerin packs. The ideal treatment for extensive burns may possibly be found to be a combination of glycerin with a local anesthetic and a suitable antiseptic dye. We intend to give further study to this application of glycerin osmotherapy as case material is available.

The Remington-Hobbs[8] glycerin treatment of uterine sepsis has not received the acceptance it merits. We have varied the original technique, in that the catheter once placed has been left undisturbed, and a half ounce of glycerin is injected every three or four hours. This procedure is a life-saving measure in apparently desperate cases, and we believe that while sulfanilamide and osmotic drainage in conjunction are more effective in relieving postpartum infection than is either alone, yet osmotic drainage is the more essential. Temperature graphs covering periods during which one or the other or both were used furnish convincing evidence for this opinion.

In cases of cancer, free drainage and osmotic dehydration of the wound seem indicated from studies in the pathologic physiology of malignancy. Cancer cells show a definite tendency to hydremia, according to Cramer,[9] and withstand deprivation of water less than do normal cells. Cancer wounds, inadequately drained, become edematous, with widened lymphatic spaces and increased lymphatic tension, conditions which facilitate the permeation of cancer cells and the development of metastases. Osmotic drainage tends to reduce cancer cell hydremia, thereby weakening the cells, and, by reducing edema and lymph tension, tends to decrease the incidence of metastases by lymphatic extension. It is also apparent that cancer cells not too deep in the open lymph channels, or cells squeezed into the wound during operative manipulations, may be washed to the drainage tract by

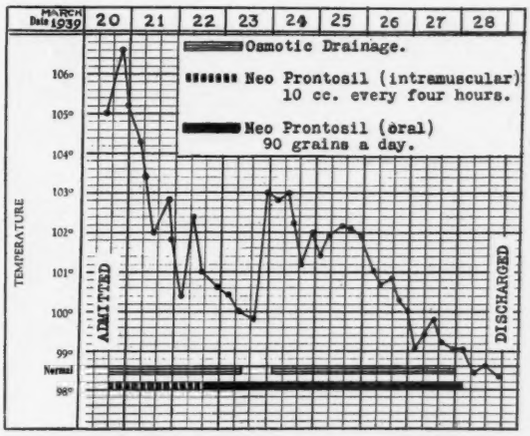

Fig. 4. Graph of temperature and periods of use of glycerin drainage and a streptostatic drug in Case A.

Summary of Case A. A para one, age 18, was admitted to the Owensboro-Daviess County Hospital March 20, 1939, with a history of an instrumental delivery March 3, 1939, followed by chills, fever and sepsis which continued. She had marked pain and rigidity in the hypogastrium, a temperature of 105°F., which rose to 106.6°F. four hours later; pulse 150. She was dehydrated from persistent vomiting. Treatment: Intravenous glucose, neoprontosil injections until the drug could be retained by mouth, and osmotic drainage by the modified Remington-Hobbs method. Note the rise in temperature on interruption of glycerin drainage.

the profuse flow of serum and be prevented from forming local recurrences.

OSMOTIC DRAINAGE IN ABDOMINAL INFECTION

In abdominal infections, under treatment with glycerin, there is usually a prompt shift of the temperature and pulse rates to a safe range. Considering the definite physiological indications, the simplicity and effectiveness of its use, it is strange that there does not seem to be a single reference in the available literature to the use of glycerin osmotherapy in the peritoneum.

Since reactions of the normal peritoneum to the application of glycerin hardly correspond to the effects of glycerin on edematous serous tissues, experimental studies may have been misleading. It is also

true that disappointing results have followed attempts to use some other antiseptics within the abdomen. The superiority of glycerin over other agents is shown by Hertzler's[10] demonstration that bichloride of mercury and iodine in the peritoneum induce an exudate in which bacteria grow splendidly, and that when bacteria and these antiseptics are introduced within the abdomen simultaneously peritonitis is more apt to develop than when bacteria are introduced alone. Irritation from these harsh antiseptics encourages bacteria more than the antiseptic power hinders their growth.

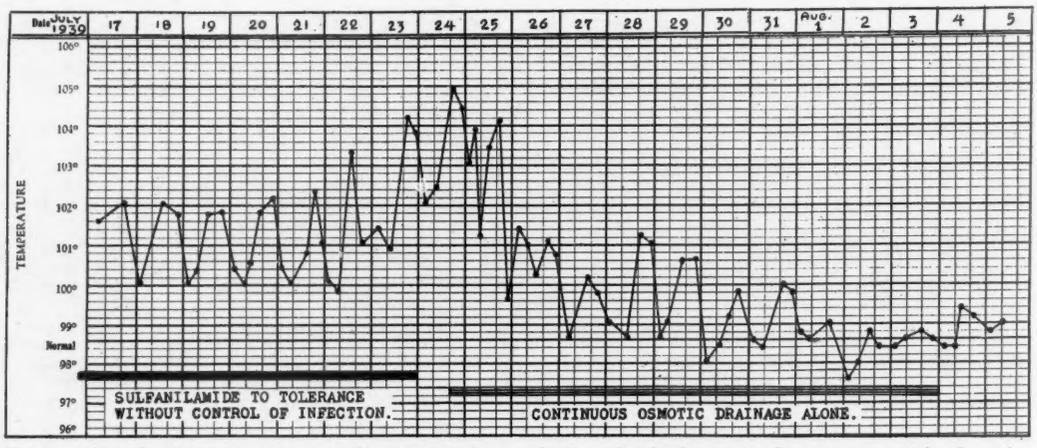

FIG. 5. Graph of temperature and periods of use of glycerin drainage and a streptostatic drug in Case B.

Summary of Case B. A para one, age 25, delivered out of the state, had septic symptoms for three weeks before returning to her Owensboro physician. Due to the development of an intolerance for sulfanilamide, which she had been receiving for three weeks, her physician instituted glycerin drainage. She had no other therapy except ferrous lextron. Note that drainage alone was quite effective in this case, but we do not recommend it be employed as the sole treatment in puerperal sepsis. Graphs of Cases A and B indicate that the use of a streptostatic drug and glycerin drainage in conjunction are more effective than either alone, but that drainage is the more essential.

In peritonitis the local increased tension favors spread of infection through radiating lymph channels, the stagnant fluids promote bacterial growth as shown by Wegner,[11] and the plastic exudate acts as a culture medium for growth of organisms, the defensive efforts of the body forming hindrances to recovery. Glycerin assists in removing these handicaps by inducing fluid discharges which wash away some of the bacteria, by reducing lymphatic tension to permit freer phagocytic action, and by removing stagnant fluids. Factors contributing to diffusion of the infection being controlled to some degree, less plastic exudate is formed to act as bacterial pablum, the duration of the infectious process is shortened, and consequently the number and density of permanent adhesions is reduced, for as has been shown by Hertzler,[12] "When an infectious process is of long duration the induced adhesions may become permanent."

Periappendiceal abscess or other established abdominal infection requires some type of mechanical drain. The selection of a drainage material, as pointed out by Horsley, should take into consideration the biologic reaction of the tissues to the material. Rubber drains act well as conduits for inflammatory products, but provoke only slight lymphatic response. On the other hand dry gauze packs excite a pronounced flow of lymph but have the disadvantage of becoming firmly fixed in the wound by the coagulation of lymph between the meshes, so that an effort to remove the gauze before this fibrin has softened, results in tearing the delicate tissues of the wound, causing bleeding. Dry gauze is therefore far from the perfect drainage material. Such a per-

fect material Horsley defines as "one which, on the one hand, is a pronounced stimulus for the lymph to be poured out along the common bile duct. The free swabbing of glycerin over the soiled areas of the peritoneum seems to be a peritonitis prophylactic.

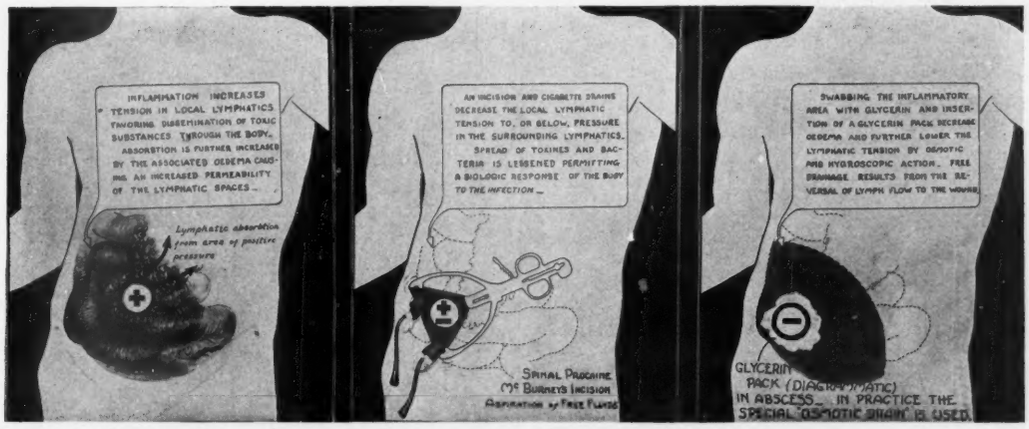
INFLAMMATION INCREASES TENSION IN LOCAL LYMPHATICS FAVORING DISSEMINATION OF TOXIC SUBSTANCES THROUGH THE BODY. ABSORBTION IS FURTHER INCREASED BY THE ASSOCIATED OEDEMA CAUSING AN INCREASED PERMEABILITY OF THE LYMPHATIC SPACES.
Lymphatic absorption from area of positive pressure
AN INCISION AND CIGARETTE DRAINS DECREASE THE LOCAL LYMPHATIC TENSION TO, OR BELOW, PRESSURE IN THE SURROUNDING LYMPHATICS. SPREAD OF TOXINES AND BACTERIA IS LESSENED PERMITTING A BIOLOGIC RESPONSE OF THE BODY TO THE INFECTION.
SPINAL PROCAINE
(Mc BURNEY'S INCISION
SWABBING THE INFLAMMATORY AREA WITH GLYCERIN AND INSERTION OF A GLYCERIN PACK DECREASE OEDEMA AND FURTHER LOWER THE LYMPHATIC TENSION BY OSMOTIC AND HYGROSCOPIC ACTION. FREE DRAINAGE RESULTS FROM THE REVERSAL OF LYMPH FLOW TO THE WOUND.
GLYCERIN
PACK (DIAGRAMMATIC)
IN ABSCESS. IN PRACTICE THE SPECIAL "OSMOTIC DRAIN" IS USED.

FIG. 6. Peri-appendiceal abscess. Inflammatory tension relieved by incision and osmotic drainage.

drain, and, on the other hand would not be sufficiently attached to the raw surface of the wound to injure it." Gauze thoroughly saturated with glycerin comes up to the specifications as an ideal drain since it promotes an even greater outpouring of lymph than does the dry gauze and does not adhere and cause bleeding when it is removed. For three years, whenever an abscess has been found in the lower abdomen, we have used glycerin-soaked gauze as a drain, and the results have been so consistently favorable that we undertake treatment of a case with a ruptured appendix and diffusing peritonitis with the confident expectation that the patient will recover.

To maintain a continuous profuse drainage from the abdomen we have devised a special drain which consists of a Kehrer's cigarette drain with a small catheter wrapped in its center so that glycerin may be injected down into the gauze within the abdomen.

Recently we have broadened the indications for intraperitoneal use of glycerin to include cases in which there has been accidental or unavoidable contamination of clean areas of the peritoneum, as when a gangrenous gall bladder spills, or when infected bile is smeared over the stomach and transverse colon during an operation on the

The free flow from the peritoneum, which may be anticipated following glycerin stimulation, is indicated by Schrader's[13] having recovered 105 c.c. of fluid from the peritoneum of a 16,000 Gm. dog forty-five minutes after injecting 25 c.c. of glycerin. Such copious discharge demands a mechanical drainage outlet and maintenance of the patient's water balance by hypodermoclysis or intravenous fluids.

While a few cases of apparently established peritonitis, with extensive distribution of fibrinous exudate, have recovered after pouring several ounces of glycerin into the abdomen and furnishing adequate drainage, no conclusion may be drawn unless these observations are supported by more clinical checks or by favorable results from the use of glycerin in induced peritonitis of laboratory animals. Glycerin drainage is not yet advocated as a cure for diffuse peritonitis, nor is it indicated when complete closure is to be done, since an osmotic agent, without a drainage outlet, would increase the stagnant fluids within the abdomen. To establish immunity in the peritoneum when judgment dictates closure of the abdomen, it is preferable to use a preparation such as coli-bactragen, as advocated by Steinberg.[14] The two procedures have different fields of application, though they apparently possess the same virtue of

rapidly evoking a phagocytic response from the body before the eighteen to twenty-four hours needed for bacteria to multiply sufficiently to produce recognizable peritonitis and soluble toxic substances.

SUMMARY

Several properties of glycerin contribute to its effectiveness as an accessory drainage agent in a variety of surgical conditions.

1. Osmotic action by reducing edema inhibits lymphatic extension of infection and increases the number of available phagocytes.

2. Hygroscopic action cleans the wound by removing discharge.

3. It is antiseptic to numerous pathogenic organisms.

4. Glycerin is relatively non-irritating and nontoxic to body cells.

5. It reduces surface tension.

6. It acts as solvent for a number of antiseptic dyes.

7. It prevents drying of the wound.

Glycerin is particularly suitable for use in infected or contaminated abdominal wounds since:

1. It reduces toxic absorption by inducing profuse drainage from the peritoneum.

2. It removes stagnant fluids and washes out wound debris.

3. Glycerin soaked drains do not adhere to endothelial tissue.

4. It tends to decrease the number of permanent adhesions.

5. It inhibits the development and diffusion of peritonitis.

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FACTORS INVOLVED IN THE PRODUCTION OF ADHESIVE PLASTER IRRITATION*

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THIS investigation was undertaken to study the factors which cause adhesive plaster irritations. The writer will also attempt to define adhesive plaster dermatitis, a term which has been used loosely in the past.[1] With the greater interest of the profession recently in the subject of allergic (contact) dermatitis, the designation allergic reaction has been carelessly applied to the manifestations of irritation of the skin occasionally caused by adhesive plaster. Furthermore, in recent months the manufacturer of one brand of adhesive plaster has made claims that his particular product is less irritating to the skin and produces fewer allergic reactions than others. It was therefore felt that a comprehensive clinical study of this problem would help to clarify the ambiguity in terminology by pointing out the nonspecific factors involved as distinguished from the allergic or specific factors.[1,2,3]

Several standard brands of adhesive plaster were employed under conditions simulating clinical usage. By testing each subject by the patch test technique it was possible to determine the presence of any sensitivity of allergic type. These experiments were carried out during a period when the temperature ranged from 60 to 89 degrees, and humidity from 25 to 100 per cent (June 19 to July 9, 1939), circumstances which placed the entire experiment under more severe conditions than are ordinarily present when medical or surgical strappings are applied.

Forty-eight adult subjects (twenty-four males and twenty-four females) received two separate clinical strappings (1) as for a rib fracture or pleurisy (Fig. 1) and (2) as for a lower back sprain. (Fig. 2.) Four standard brands of adhesive tape were chosen: Bauer and Black formula 87, Bay Adhesive, Johnson and Johnson "Z.O." and Seamless Rubber. These are referred to as *A*, *B*, *C*, and *D*, but it shall not be stated in this communication which of the brands was designated by each of the four letters.

All four specimens of adhesive plaster were used for the strappings in 3 inch width strips on each subject. *A* was applied, with considerable tension, to the chest posteriorly beginning several inches from the spinal column on the right and continuing around to a few inches beyond the midsternal line on the right, thereby encircling over one half the circumference of the chest. *B* was applied in the same manner just below *A*. *C* extended across the lower back from the anterior superior spine on one side to the same location on the other, its upper edge being at the level of the crests of the iliac bones. *D* was applied just below *C*. At times overlapping of ½ to 1 inch occurred between *A* and *B*, and *C* and *D*. In order that no one brand of adhesive should have any advantage by virtue of the position on the part of the body which it occupied, a series of formulae was worked out so that each brand occupied every position six times in both male and female groups.

Patch tests with each brand of adhesive plaster were applied without tension to the lateral surfaces of each thigh in the form of strips 2½ to 3 inches long, and 1 inch wide, one below the other and separated by ½ to ¾ inch. (Fig. 3.) They were arranged from above down in an order corresponding to the formula used for the clinical strappings.

Volunteers for the above studies consisted of hospital employees engaged as laboratory technicians and helpers, orderlies, aides, clerks, porters, and secretaries. Each subject was required to retain the

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strappings and corresponding patch tests, which were to be kept dry, for a full week, and to report at indicated intervals for inspection. Each person was questioned as to age, occupation, personal and family history of atopic diseases, the occurrence of a contact dermatitis in the past, a history of prolonged contact with adhesive plaster and of known irritation by it. They were examined for color of the hair and its distribution at the sites used for adhesive plaster application. The shade of the skin was noted, and the skin was stroked over the upper back to determine dermographism. No special preparation of the skin was required other than previous shaving off of hair from the areas of skin to be used, and bathing on the morning when the adhesive plaster was to be applied.

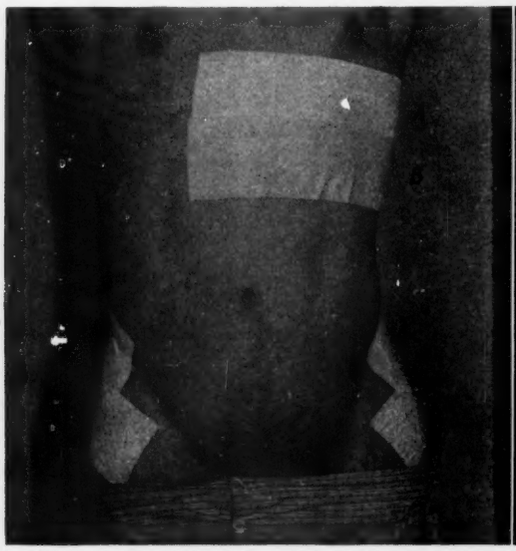


FIG. 1. Anterior view. A, B, C and D represent four standard brands of adhesive plaster; A-B, strapping for rib fracture or pleurisy; C-D, strapping for lower back sprain.

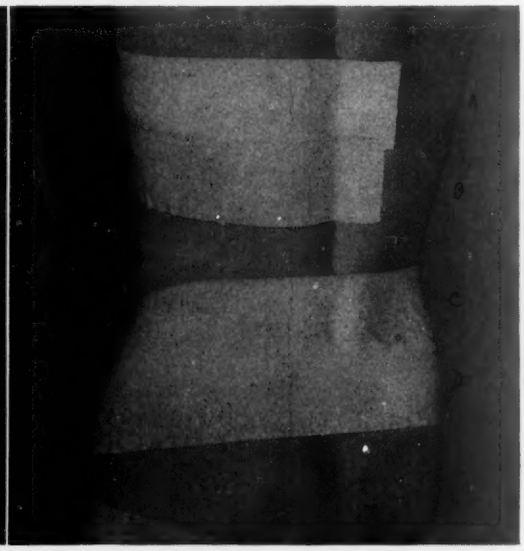


FIG. 2. Posterior view. A, B, C and D represent four standard brands of adhesive plaster; A-B, strapping for rib fracture or pleurisy; C-D, strapping for lower back sprain.

TABULATION OF REACTIONS

The patch tests on the left thigh were removed forty-eight hours after application, this interval being generally recognized as the longest desirable period of contact for the conventional test. An aller-

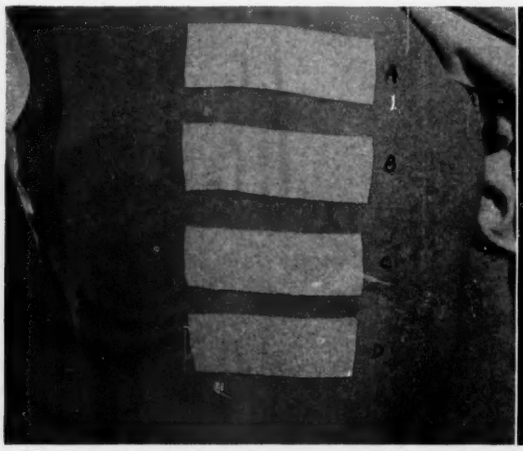


FIG. 3. Control patch tests on thighs with strips of adhesive plasters A, B, C and D.

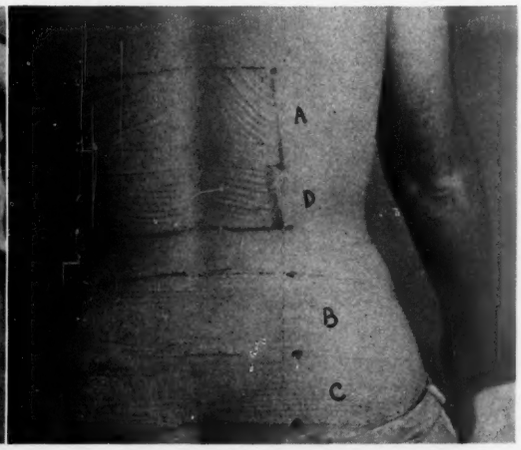


FIG. 4. Subject No. 3, female, with fair skin. After removal of the seven-day strappings there was essentially no skin irritation (TNV = 2 to 2.5).

gic adhesive plaster dermatitis, if present, would most certainly be in evidence at this time. These sites were again inspected and read four and seven days after application. The remaining patch tests (right thigh), and all the strappings were removed seven days after the initial application, and readings taken.

Prior to final removal of the strappings each subject was questioned as to whether he had suffered any discomfort such as itching, burning, pain, etc. Any evidence of irritation of the skin was recorded following removal of the adhesive plaster. Photographs of the right thigh and of the back were taken in many instances, but only those which illustrate a particular point are presented. The sites of the thigh tests and of the chest and back strappings were inspected two and four days after removal (nine and eleven day reading). In recording reactions, the writer, being unacquainted with the identity of the individual strips on each subject, called off his findings to a secretary, referring to the strips of adhesive from above down as patch 1, 2, 3, 4, or strapping, 1, 2, 3, 4.

The presence of erythema was recorded as E±, +, ++, or +++, depending on the degree of redness of the skin. Papules were designated by Pa±, +, ++, or +++. At times when papules were numerous, they were interspersed with pustules, noted as Pu±, +, ++, or +++. The number of pustules was always less than the papules, and was therefore included as part of the reading for the degree of papule production. Such findings as infiltration of the skin, vesiculation, and desquamation, which are commonly present with a true contact (allergic) dermatitis, were not seen in a single instance.

In order to simplify interpretation of the reactions and to eliminate the personal element in comparing the findings, the readings were recorded numerically. A single plus was given the value of 1; a plus-minus reading was graded 0.5, these evaluations applying alike to erythema, papules, or pustules. The letters NV were used to denote the *numerical value of irritation*, e.g., NVE (for erythema) and NVPa (for Papules). By adding together NVE and NVPa the *total numerical value* (TNV) for irritation was obtained. Thus it was possible to compare adhesive plasters *A*, *B*, *C*, and *D* numerically in individual subjects or groups for the total amount of irritation produced by each. Personal interpretations did not therefore enter into the final comparisons.

Table 1 contains all the data: The first column indicates the number of the subject and the formula used in applying the four adhesive plasters. Atopy included related illnesses in the subject or his family. For past contact with adhesive plaster only those experiences were noted wherein adhesive plaster was used as a strapping over a fair-sized area of skin for at least five to seven days. The reactions produced by the four brands of adhesive plasters are recorded in the respective columns *A*, *B*, *C*, and *D*.

The two-day patch reading was obtained after removal of the patch from the left thigh (for purpose of detecting any true allergic dermatitis). Later readings of this site were not considered of sufficient importance to warrant recording. At the bottom of this column (two-day patch) is recorded the TNV in the forty-eight subjects. The seven, nine, and eleven-day readings pertain to the findings on the right thigh, and are unrelated to the two-day readings just mentioned. These values are to be compared with the seven, nine and eleven-day readings recorded under Strapping. The NVE and NVPa for each subject are recorded in the adjoining column, while the sum total of these, or TNV for forty-eight subjects are indicated at the bottom of these columns. The TNV are again recorded together at the extreme end of the table, so that the degrees of irritation in any subject or in the entire group of subjects can be compared.

Table 11 presents a summary of the findings for the determination of differences in response to adhesive plaster application

TABLE I

No.	Sex	Age	Occupation	Atopy	Dermatitis Venenata	Past Adhesive Plaster Contact	Stature	Hair		Skin		Remarks Concerning Strapping
								Color	Distribution	Shade	Dermographism	
1 *ABCD*	♂	42	Clerk	H. F. hives at 12 yrs.	0	Back 6 yrs. ago, 1 wk.	Med. ht. and wt.	Black	Sl. chest, back, thighs	Dark	E+ Uo = Urticaria neg.	Sl. itch at night.
2 *ACBD*	♂	31	Porter	0	0	0	Med. ht. and wt.	Med. brown	Mod. chest, thighs. None back	Med.	E+ Uo	No itch until 6th day.
3 *ADBC*	♂	37	Orderly	0	0	Ankle, 2 yrs. ago, several wks.	Med. ht. and wt.	Lt. brown	None chest, back sl. thighs	Fair	E+ Uo	Sl. itching last 3 days.
4 *BACD*	♂	32	Laundry helper	0	0	Back, 1 mo. ago, 2 wks.	Tall. Med. wt.	Lt. brown	V. sl. chest, back mod. thighs	Fair	E+ Uo	Practically no itching.
5 *BCAD*	♂	27	Pharmacy helper	0	0	0	Short, stout	Med. brown	None chest v. sl. back sl. thighs	Med.	E+ Uo	Sl. itching after 3rd day.
6 *BDAC*	♂	32	Porter	0	0	0	Med. ht., wt.	Dark brown	None chest, back sl. thighs	Med.	E± Uo	No itching. Chest strapping tight.
7 *CABD*	♂	23	Morgue helper	0	0	Chest 5 yrs. ago, 6 days.	Med. ht., wt.	Med. brown	St. chest, back, thighs	Fair	E+ Uo	Sl. itching chest after 4th day.
8 *CBAD*	♂	24	Morgue helper	0	0	Ankle, 7 yrs. ago, 10 days	Med. ht., thin	Red	V. sl. chest sl. bac, mod. thighs	Fair	E+ Uo	V. Sl. itch after 5th day.
9 *CDAB*	♂	27	Pharmacy helper	0	0	Chest 1 yr. ago, 11 days	Med. ht., slim	Med. brown	None chest, back, v. sl. thighs	Med.	E+ Uo	Sl. itch after 3rd day.
10 *DABC*	♂	20	Elevator operator	0	0	Ankle, 4 yrs. ago, 2 wks. clavicle, 8 yrs. ago, 6 6 wks. append. 1 yr. ago	Short, slim	Dark brown	Sl. back, thighs	Med.	E+± Uo	V. sl. itch after 5th day.
11 *DBAC*	♂	19	Porter	Eczema—ears childhood	0	0	Short, med. wt.	Lt. brown	V. sl. chest, back mod. thighs	Med.	E+± Uo	Sl. itching on 6th day.
12 *DCAB*	♂	59	Orderly	0	0	0	Med. ht., wt	Lt. brown	None	Fair	E++ U±	No itching. Sl. tightness.
13 *ABDC*	♂	39	Orderly	0	0	Append. 16 yrs. ago	Tall, med. wt.	Med. brown	Sl. chest, back, thighs	Med.	E+ Uo	Sl. itching after 1st day.
14 *ACDB*	♂	20	Path. lab. helper	0	0	Back 5 yrs. ago, 1 wk.	Med. ht., slim	Black	Sl. back, chest mkd. thighs	Dark	E++ Uo	Mkd. itch chest 24 hrs. after application. V. sl. itch—back.
15 *ADCB*	♂	18	Clerk	0	0	Abdominal injury 4 yrs. ago, 1 wk.	Short, med. wt.	Med. brown	V. sl. chest, mod. back, thighs	Med.	E± Uo	No discomfort.

16 *BADC*	♂	64	Porter	0	0	0	Short, slim	Med. brown. gray	None chest, back. sl. thighs	Med.	E+ Uo	V. sl. itching after 3rd day.
17 *BCDA*	♂	29	Clerk	0	0	0	Short, med. wt.	Black	V. sl. back mod. thighs	Dark	E+ Uo	V. sl. itching after 3rd day.
18 *BDCA*	♂	26	Porter	0	0	0	Med. ht., wt.	Med. brown	V. sl. back mod. thighs	Med.	E+ Uo	Sl. itching last day. Tight across chest.
19 *CADB*	♂	44	Porter	0	0	Knee 27 yrs. ago, 2 wks.	Med. ht., wt.	Med. brown	V. Sl. thighs	Med.	E± Uo	No complaints.
20 *CBDA*	♂	22	Cafeteria helper	0	0	0	Short, med. wt.	Black	None chest. Sl. back mod. thighs	Med.	E+± Uo	Sl. itching since application. Considerable last day.
21 *CDBA*	♂	21	Elevator operator	0	0	0	Tall, slim	Med. brown	Sl. chest, back mod. thighs	Med.	E+ Uo	V. sl. itching after 4th day.
22 *DACB*	♂	33	Orderly	Sister has hives	Poison ivy. 1928	Back, chest 1 yr. ago, 2 mos.	Tall. med. wt.	Med. brown	Sl. thighs	Med.	E+± Uo	V. sl. itching after 3rd day.
23 *DBCA*	♂	21	Orderly	0	0	0	Med. ht., wt.	Med. brown	V. sl. back sl. thighs	Med.	E+± Uo	Sl. itching after 1st day.
24 *DCBA*	♂	31	Orderly	Hives rarely	0	0	Short, med. wt.	Black	Mod. chest, back, thighs	Med.	E+ Uo	Sl. itching after 4th day.
1 *ABCD*	♁	19	Aide	0	0	Ankle 3 yrs. ago, 3 days	Med. ht., stout	Black	Sl. thighs	Med.	E++ Uo	Chest itch sl. after 3rd day back not bothersome.
2 *ACBD*	♁	20	Aide	0	0	0	Tall, slim	Dark brown	Sl. thighs	Med.	E++ Uo	Sl. itching after 3rd day.
3 *ADBC*	♁	21	Lab. technician	0	0	0	Med. ht., wt.	Red	None	Fair	E+ Uo	V. little itching after 3rd day.
4 *BACD*	♁	50	Aide	Father—asthma	0	0	Tall, stout	Black	None	Med.	E± Uo	V. sl. itching after 1st day.
5 *BCAD*	♁	25	Aide	Father—asthma	0	0	Short, stout	Black	V. sl. back	Med.	E+ Uo	V. sl. itching after 1st day.
6 *BDAC*	♁	44	*X*-ray aide	0	0	Abdominal operation 4 yrs. ago	Short, med. wt.	Gray blonde	None	Fair	E+ Uo	Sl. itching 3rd & 4th days.
7 *CABD*	♁	24	Secretary	0	0	Ankle strapping 5 yrs. Frequently	Short, thin	Black	Sl. chest, back, thighs	Dark	E+ Uo	V. little itching after 3rd day.
8 *CBAD*	♁	23	Lab. technician	Occ. hives sister, nephew asthma	Poison ivy last yr.	Ankle 1 yr. ago 1 wk.	Med. ht., slim	Black	None	Med.	E+++ U+	Sl. itching since application. mod. last day.
9 *CDAB*	♁	20	Lab. technician	0	0	0	Short, med. wt.	Black	Sl. back, thigh	Dark	E± Uo	Sl. itch lower back after 3rd day.

TABLE I (*Continued*)

No.	Sex	Age	Occupation	Atopy	Dermatitis Venenata	Past Adhesive Plaster Contact	Stature	Hair		Skin		Remarks Concerning Strapping
								Color	Distribution	Shade	Dermographism	
10 *DABC*	♂	21	Lab. technician	0	0	Append. 2 yrs. ago	Med. ht., wt.	Med. brown	Sl. back mod. thighs	Med.	E+ Uo	Practically no itching.
11 *DBAC*	♂	24	Aide	0	0	0	Med. ht., stout	Med. brown	None back, chest v. sl. thighs	Fair	E+ Uo	Sl. itching past 2 days.
12 *DCAB*	♂	30	Aide	0	0	Leg 1 mo. ago 1 wk.	Med. ht., wt.	Lt. brown	V. sl. back, thighs	Fair	E± Uo	Sl. itching past 2 or 3 days.
13 *ABDC*	♂	22	Aide	0	0	Back 1 yr. ago 1 wk.	Med. ht., wt.	Dark brown	Sl. lower back v. sl. thighs	Fair	E+ Uo	V. sl. itching after 3rd day.
14 *ACDB*	♂	31	Aide	0	0	Back 1 mo.	Med. ht., wt.	Dark brown	None	Fair	E± Uo	Sl. itching 3rd night.
15 *ADCB*	♂	42	Aide	0	0	0	Med. ht., wt.	Blonde	V. sl. lower back	Fair	Eo Uo	Mod. itching after 3rd day.
16 *BADC*	♂	24	Aide	0	0	0	Med. ht., thin	Lt. brown	V. Sl. back	Fair	E++ U±	V. sl. itching last day.
17 *BCDA*	♂	28	Aide	0	0	Append. 7 yrs. ago	Short, med. wt.	Med. brown	None	Fair	E+ Uo	V. sl. itching after 3rd day.
+ 18 *BDCA*	♂	26	Clerk	Occasional hives	Summer rash 10 yrs.	0	Short, stout	Reddish brown	Sl. back, thighs	Dark	E+ Uo	Sl. itching past 3 days.
19 *CADB*	♂	32	Aide	Occasional hives	0	Ankle 5 yrs. ago 1 wk.	Med. ht., wt.	Black	None	Med.	E++ U+	V. sl. itching after 2nd day.
20 *CBDA*	♂	22	Lab. technician	0	0	Mastoid dressing 11 yrs. ago 3 wks.	Med. ht., wt.	Med. brown	V. sl. chest, back, thighs	Med.	E+± Uo	V. sl. itching after 2nd day.
21 *CDBA*	♂	19	Clerk	0	0	0	Med. ht., wt.	Lt. brown	V. sl. back sl. thighs	Fair	E+± Uo	V. sl. itching after 3rd day.
22 *DACB*	♂	20	Messenger	0	0	Ankle 3 yrs. ago 2 wks.	Short, slim	Dark brown	V. sl. thighs	Med.	E+ Uo	Sl. itching 1st day.
23 *DBCA*	♂	22	Lab. technician	0	0	0	Short, med. wt.	Black	V. sl. chest, thighs sl. back	Med.	E± Uo	V. sl. itching since application.
24 *DCBA*	♂	22	Secretary	0	0	Append. 6 yrs. ago	Med. ht., slim	Lt. brown	Sl. thighs	Fair	E+ Uo	Tight 1st few days. No itching.

TABLE I (*Continued*)

No.	Adhesive Plaster *A*									Adhesive Plaster *B*								
	Patch				Strapping			Total		Patch				Strapping			Total	
	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa
1 *ABCD*	0	0	0	0	E+ Pu±	E+ Pa±	E+± Pa±	3.5	1.5	0	0	0	0	E+ Pu±	E+ Pa±	E+± Pa±	3.5	1.5
2 *ACBD*	0	Pa±	E± Pa±	E± Pa±	E+ Pu++	E+ Pa++	E+± Pa+	3.5	5.0	E±	E±	E+	E±	E+ Pu++±	E+± Pa+++	E± Pa++	3.0	7.5
3 *ADBC*	E+	E± Pa±	0	0	Pu++	E+ Pa+	E+ Pa±	2.0	3.5	E+	E+	E±	E±	Pu+++	E+± Pa++±	E+ Pa+±	2.5	7.0
4 *BACD*	0	Pa±	0	.....	Pa+	Pa±	.....	0	1.5	0	Pa±	0	.....	Pa+±	E± Pa±	.....	0.5	2.0
5 *BCAD*	E+	E+	E±	E±	E++	E+	E+	4.0	0	E+	E+	E±	E±	E±	E+±	E+±	3.5	0
6 *BDAC*	0	Pa±	E±	E±	E+±	E±	E±	2.5	0	0	0	E±	E±	E± Pa+	E+± Pa±	E+	3.0	1.5
7 *CABD*	0	0	E±	E±	E++ Pa+	E+	E±	3.5	1.0	0	0	E±	E±	0	E±	E±	1.0	0
8 *CBAD*	E±	E± Pa±	E±	E±	E+± Pa±	E+ Pa±	E±	3.0	1.0	0	E±	E±	E±	E+ Pa+	E+	E±	2.5	1.0
9 *CDAB*	0	0	E±	E±	E+	E±	E±	2.0	0	0	0	E±	E±	Pu+	E+ Pa+±	E± Pa+	1.5	2.5
10 *DABC*	0	0	0	0	E± Pa+	E± Pa+	E± Pa±	1.5	2.5	0	0	0	0	E± Pa+± Pu+	Pa++ Pu±	Pa+±	0.5	5.0
11 *DBAC*	E±	Pa±	0	0	Pa+±	Pa+±	Pa+±	0	4.5	0	Pa±	E±	E±	E± Pa+	Pa+	Pa+	0.5	3.0
12 *DCAB*	E±	E±	E±	E±	E+± Pa+	E± Pa+	E± Pa±	2.5	2.5	E+	E±	E±	E±	E+ Pa+	E± Pa±	E± Pa±	2.0	2.0
13 *ABDC*	0	Pa±	E±	E±	E+± Pa±	E+ Pa±	E+	3.5	1.0	0	Pa±	E±	E±	E+ Pa+	E+ Pa+	E+ Pa±	3.0	2.5
14 *ACDB*	E±	Pa+	E± Pa±	E± Pa±	E+++ Pu+	E+ Pa+	E± Pa±	4.5	2.5	E±	Pa+	E±	E±	E++ Pu++	E± Pa++	E± Pa+±	3.0	5.5
15 *ADCB*	E±	E± Pa±	0	0	E± Pa++ Pu+	E± Pa+±	E± Pa+	2.0	4.5	E±	E±	E±	0	E± Pa+	Pa±	0	0.5	1.5

TABLE I (*Continued*)

No.	Adhesive Plaster *A*									Adhesive Plaster *B*								
	Patch				Strapping			Total		Patch				Strapping			Total	
	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa
16 *BADC*	E+	E±	0	0	E+ Pu±	E±	E±	2.0	0.5	E+	E±	0	0	E+ Pu±	E± Pa±	E±	2.0	1.0
17 *BCDA*	0	0	0	0	E+± Pa±	0	0	1.5	0.5	0	0	0	0	E++ Pa++	E± Pa+	E± Pa+	3.0	4.0
18 *BDCA*	E+	E+	E±	E±	E++ Pu±	E± Pa+	E± Pa±	3.0	2.0	E+	E+	E±	E±	E+ Pa±	E± Pa±	E±	2.0	1.0
19 *CADB*	0	0	E±	E±	E± Pa++ Pu+	E+ Pa+±	E+ Pa+±	2.5	4.5	0	E± Pu+	E+ Pa+	E± Pa+	E± Pa+	E± Pa±	E± Pa±	1.5	2.0
20 *CBDA*	Pa+	E± Pa±	E± Pa±	.....	E+± Pa+	E+ Pa±	.....	2.5	1.5	Pa+	E± Pa+	E± Pa±	.....	E+ Pu+	E+ Pa±	.....	2.0	1.5
21 *CDBA*	0	E± Pa±	E±	0	E± Pa++ Pu±	E+± Pa++	E± Pa+±	2.5	5.5	0	E± Pa±	E±	0	E± Pa++ Pu+	E+ Pa+±	E± Pa+	2.0	4.5
22 *DACB*	E±	E± Pa±	0	.....	E++	E+	.....	3.0	0	E±	Pa±	0	.....	E± Pa±	E± Pa±	.....	1.0	1.0
23 *DBCA*	Pa+	0	E±	E±	E+ Pa+	E+ Pa+	E± Pa+	2.5	3.0	Pa+	0	E±	E±	E+ Pa±	E+	E±	3.5	0.5
24 *DCBA*	E+	E+	E±	E±	E++ Pa±	E+± Pa±	E+ Pa±	4.5	2.5	E±	E+	E±	E±	E++ Pu+	E+± Pa+ Pu±	E+ Pa+	4.5	3.0
1 *ABCD*	0	0	0	0	E+	E+	E±	2.5	0	0	0	0	0	E+	E+	E±	2.5	0
2 *ACBD*	E±	Pu+	Pa++	E± Pa+	E+ Pa++ Pu+	E± Pa++	E± Pa++	2.0	5.5	0	Pa±	Pa±	E± Pa±	E++ Pa+++ Pu±	E± Pa++	E+ Pa+++	3.5	7.0
3 *ADBC*	0	E±	E±	E±	E±	E+	E±	2.0	0	0	E±	E±	E±	E±	E+	E±	2.0	0
4 *BACD*	0 *RR*	E±	0	0	E+	0	0	1.0	0	0	E±	0	0	E+	0	0	1.0	0
5 *BCAD*	0	0	E±	E±	E+ Pa+	Pa+	Pa+	1.0	3.0	0	0	E±	E±	E+ Pa+	E+ Pa+±	E+ Pa+	3.0	3.5
6 *BDAC*	0	0	E±	.....	E± Pa±	E± Pa±	.....	1.0	1.0	E+ Pa++	0	E±	.....	E+± Pa+±	E+ Pa± ±	.....	2.5	3.0

7 *CABD*	E+	E±	E±	0	E+±	0	0	1.5	0	0	E±	E±	0	E++	0	0	2.0	0
8 *CBAD*	E+	0	0	0	E++	Pa+	Pa±	2.0	1.5	0	0	0	0	E+	E± Pa++	E± Pa+	2.0	3.0
9 *CDAB*	0	Pa±	0	0	Pa++	Pa±	E± Pa+	0.5	3.5	0	Pa±	0	0	Pa+	Pa±	E± Pa+	0.5	2. 5
10 *DABC*	E+	0	0	0	E++ Pa±	Pa±	Pa±	2.0	1.5	0	0	0	0	E++	Pa±	0	2.0	0.5
11 *DBAC*	0	0	0	0	E± Pa±	Pa±	0	0.5	1.0	0	0	0	0	E± Pa+	E± Pa+	E± Pa±	1.5	2.5
12 *DCAB*	E+	Pa±	E±	E±	E+ Pa++	Pa+± Pu+	E+ Pa+±	2.0	5.0	E+	Pa±	E±	E±	E+ Pa++	Pa++ Pu±	E+ Pa+±	2.0	5.5
13 *ABDC*	0	0	0	0	E± Pa+±	Pa+±	E± Pa+±	1.0	4.5	0	0	0	0	E± Pa+	Pa+	E± Pa+	1.0	3.0
14 *ACDB*	E±	0	0	0	E±	E±	0	1.0	0	0	0	0	0	E± Pa±	E± Pa±	Pa±	1.0	1.5
15 *ADCB*	0	E± Pa+	E±	0	E++	E±	0	2.5	0	0	E± Pa+	E±	0	E+± Pa+	Pa±	0	1.5	1.5
16 *BADC*	E±	E+	E±	E±	E++	E±	E±	3.0	0	E±	E+	E±	E±	E++	E±	E±	3.0	0
17 *BCDA*	0	E±	E±	.....	E± Pa±	E± Pa±	.....	1.0	1.0	0	E±	E±	.....	E+ Pa+	E± Pa+	.....	1.5	2.0
18 *BDCA*	0	E±	E±	E±	E+ Pa+	Pa±	Pa±	1.0	2.0	0	E±	E±	E±	E+ Pa++ Pu+	E± Pa+	E± Pa±	2.0	3.5
19 *CADB*	0	0	0	0	E++	0	0	2.0	0	0	E±	0	0	E++	0	0	2.0	0
20 *CBDA*	E±	E±	0	0	E+± Pa±	E±	E±	2.5	0.5	E±	0	0	0	E± Pa±	E±	E±	1.5	0.5
21 *CDBA*	E±	E± Pa±	E±	0	E+±	E±	0	2.0	0	0	E+ Pa±	E±	0	E+± Pa±	E±	0	2.0	0.5
22 *DACB*	E±	0	0	0	E± Pu±	E± Pa±	E± Pa+	1.5	2.0	E±	0	0	0	E+ Pu+±	E± Pa+	E± Pa+	2.0	3.5
23 *DBCA*	E±	0	0	0	E± Pa+±	Pa±	Pa+±	0.5	4.0	0	0	0	0	E± Pa++ Pu+	Pa++ Pu±	E± Pa++	1.0	6.0
24 *DCBA*	0	E±	E±	E±	E++	0	0	2.0	0	0	E±	E±	E±	E+	0	0	1.0	0
	17.5	.....	.....	.....	.....	.....	.....	100.5	85.5	15.0	.....	.....	.....	....	.....	.....	95.0	111.5
								186 = *A*									206.5 = *B*	

TABLE I (*Continued*)

No.	Adhesive Plaster *C*									Adhesive Plaster *D*									Numerical Value of Irritation (TNV)			
	Patch			Strapping				Total		Patch					Strapping		Total					
	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa	*A*	*B*	*C*	*D*
1 *ABCD*	o	o	o	o	E±	o	o	0.5	o	o	o	o	o	E±	o	o	0.5	o	5.0	5.0	0.5	0.5
2 *ACBD*	o	o	E+	E±	E+ Pu++	E+ Pa++	E+ Pa+	3.0	5.0	o	E±	E+	E±	E+ Pu+++±	E+± Pa+++	E± Pa++	3.0	7.5	8.5	10.5	8.0	10.5
3 *ADBC*	E+	E±	E±	o	E± Pu++	E± Pa++	E+ Pa+	2.0	3.5	E+	E+	E±	E±	Pu++	E+ Pa++	E+ Pa+	2.0	4.5	5.5	9.5	5.5	6.5
4 *BACD*	o	Pa±	E± Pa±	.....	Pa+	Pa±	.....	o	1.5	o	Pa±	E±	.....	Pa++±	Pa+	.....	o	2.5	1.5	2.5	1.5	2.5
5 *BCAD*	E+	E+	E±	E±	E±	E+±	E+±	3.5	o	E+	E+	E±	E±	E++	E+	E+	4.0	o	4.0	3.5	3.5	4.0
6 *BDAC*	o	Pa±	E±	E±	Pa±	o	E±	0.5	0.5	o	Pa±	E±	E±	E± Pa+	E+	E+	2.5	1.0	2.5	4.5	1.0	3.5
7 *CABD*	o	Pa±	E±	E±	E++ Pa+	E+±	E±	4.0	1.0	o	Pa±	E±	E±	E± Pa±	E+ Pa±	E± Pa±	2.0	1.5	4.5	1.0	5.0	3.5
8 *CBAD*	o	E± Pa+	E± Pa+	E±	E±	E+	E±	2.5	o	E±	E±	E+	E±	E+± Pa±	E+ Pa±	E±	3.0	1.0	4.0	3.5	2.5	4.0
9 *CDAB*	o	Pa±	E±	E±	Pu++	E+ Pa++	E+ Pa+	2.0	5.0	o	Pa±	E±	E±	Pu++	E+ Pa++	E+ Pa+	2.0	5.0	2.0	4.0	7.0	7.0
10 *DABC*	o	o	o	o	E± Pa++	Pa++	Pa+±	0.5	5.0	o	o	o	o	E+ Pa++	E± Pa++	E± Pa+	2.0	4.0	4.0	5.5	5.5	6.0
11 *DBAC*	o	o	o	o	Pa++	Pa+	Pa±	o	3.0	o	Pa±	E±	E±	Pa+	Pa±	o	o	1.5	4.5	3.5	3.0	1.5
12 *DCAB*	E±	E±	E±	E±	E++ Pa+	E+ Pa+	E± Pa±	3.5	2.5	E±	E±	o	o	E++ Pa+	E+ Pa+	E± Pa±	3.5	2.5	5.0	4.0	6.0	6.0
13 *ABDC*	o	E± Pa±	E±	E±	E+ Pa+	E± Pa+	E+ Pa±	2.5	2.5	o	Pa±	E±	E±	E+ Pa±	E± Pa±	E+	2.5	1.0	4.5	5.5	5.0	3.5
14 *ACDB*	E±	Pa+	E± Pa±	E± Pa±	E++ Pu+	E± Pa+	E± Pa±	3.0	2.5	E±	Pa+	E±	E±	E+++ Pu+±	E± Pa++	E± Pa+	4.0	4.5	7.0	8.5	5.5	8.5
15 *ADCB*	E±	E±	o	o	E± Pa±	E±	o	1.0	0.5	E±	E± Pa±	o	o	E± Pa++ Pu+	E+ Pa+	E± Pa±	2.0	3.5	6.5	2.0	1.5	5.5

16 *BADC*	E+	E±	o	o	E+± Pu±	E±	E±	2.5	0.5	E+	E±	o	o	E++	E±	E±	3.0	0	2.5	3.0	3.0	3.0
17 *BCDA*	o	o	o	o	E++ Pa++	E± Pa±	E± Pa±	3.0	3.0	o	o	o	o	E+±	o	o	1.5	0	2.0	7.0	6.0	1.5
18 *BDCA*	E+	E+	E±	E±	E++ Pu±	E± Pa±	E± Pa±	3.0	1.5	E+	E+	E±	E±	E+	E±	E±	2.0	0	5.0	3.0	4.5	2.0
19 *CADB*	o	Pa±	E±	E±	E+ Pa++ Pu+	E++ Pa++	E++ Pa++	4.0	6.0	o	E±	E±	E±	E± Pa+	E± Pa+	E± Pa+	1.5	3.0	7.0	3.5	10.0	4.5
20 *CBDA*	Pa+	E± Pa+	E± Pa±	.....	E± Pu+±	E+ Pa+	.....	2.0	2.0	Pa+	E± Pa+	E± Pa±	.....	E+± Pa+±	E+ Pa+	.....	2.5	2.5	4.0	3.5	4.0	5.0
21 *CDBA*	o	E± Pa±	E±	o	E± Pa+±	E± Pa+±	Pa+	1.0	4.0	o	E± Pa±	E±	o	E± Pa+	E± Pa+	Pa+	1.0	3.0	8.0	6.5	5.0	4.0
22 *DACB*	E±	Pa±	o	.....	E++	E±	.....	2.5	o	E±	E± Pa±	o	.....	E++ Pa±	E+	.....	3.0	0.5	3.0	2.0	2.5	3.5
23 *DBCA*	Pa+	o	E±	E±	E+ Pa±	E±	E±	2.0	0.5	Pa+	o	E±	E±	E+± Pa±	E+	E±	3.0	0.5	5.5	4.0	2.5	3.5
24 *DCBA*	E±	E+	E±	E±	E+± Pa+± Pu±	E+± Pa+ Pu+	E+ Pa+	4.0	3.5	E±	E+	E±	E±	E++ Pa+± Pu+	E+± Pa+± Pu±	E+ Pa+±	4.5	4.5	6.0	7.5	7.5	9.0
1 *ABCD*	o	o	o	o	E+	o	o	1.0	o	o	o	o	o	E+	o	o	1.0	0	2.5	2.5	1.0	1.0
2 *ACBD*	o	Pu+	Pa+±	E± Pa+	E+ Pa+± Pu+	E± Pa+±	E± Pa+±	2.0	4.5	o	Pa±	Pa±	E± Pa±	E++ Pa++± Pu+	E± Pa++±	E+ Pa++	3.5	7.0	7.5	10.5	6.5	10.5
3 *ADBC*	o	o	E±	E±	E±	E+	E+	2.5	o	o	E±	E±	E±	E±	E+	E±	2.0	0	2.0	2.0	2.5	2.0
4 *BACD*	o	E±	o	o	o	o	o	o	o	o	E±	o	o	o	o	o	o	o	1.0	1.0	o	o
5 *BCAD*	o	o	E±	E±	E+	E+	E+	3.0	o	o	o	E±	E±	E+ Pa+	Pa+	Pa±	1.0	2.5	4.0	6.5	3.0	3.5
6 *BDAC*	o	o	E±	.....	E±	E±	.....	1.0	o	E± Pa±	o	E±	.....	E+ Pa+	E± Pa+	.....	1.5	2.0	2.0	5.5	1.0	3.5
7 *CABD*	o	E±	E±	o	E++	o	o	2.0	o	o	E±	E±	o	E++	o	o	2.0	0	1.5	2.0	2.0	2.0
8 *CBAD*	o	o	o	o	E+++	E± Pa+	E±	3.5	1.0	o	o	o	o	E++	Pa+	Pa±	2.0	1.5	3.5	5.0	4.5	3.5
9 *CDAB*	o	Pa±	o	o	Pa++	Pa+	E± Pa+±	0.5	4.5	o	Pa±	o	o	Pa+++	Pa++	Pa++	o	6.5	4.0	3.0	5.0	6.5
10 *DABC*	o	o	o	o	E++	o	o	2.0	o	o	o	o	o	E++	Pa±	o	2.0	0.5	3.5	2.5	2.0	2.5

TABLE I (*Continued*)

No.	Adhesive Plaster *C*									Adhesive Plaster *D*									Numerical Value of Irritation (TNV)			
	Patch			Strapping				Total		Patch					Strapping		Total					
	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	NVE	NVPa	*A*	*B*	*C*	*D*
11 *DBAC*	0	0	0	0	E± Pa±	Pa±	Pa±	0.5	1.5	0	0	0	0	E+ Pa+	E± Pa+	E± Pa±	2.0	2.5	1.5	4.0	2.0	4.5
12 *DCAB*	E+	Pa±	E±	E±	Pa+++±	E± Pa++	E+ Pa++	1.5	6.5	E+	Pa±	E±	E±	Pa++	E± Pa+±	E+ Pa+±	1.5	5.0	7.0	7.5	8.0	6.5
13 *ABDC*	0	0	0	0	Pa+	Pa+	Pa+	0	3.0	0	0	0	0	Pa+±	Pa++	Pa±	0	4.0	5.5	4.0	3.0	4.0
14 *ACDB*	E±	0	0	0	E±	E+	E±	2.0	0	E±	0	0	0	E± Pa±	E± Pa±	Pa±	1.0	1.5	1.0	2.5	2.0	2.5
15 *ADCB*	0	E± Pa+	E±	0	E++ Pa±	Pa±	0	2.0	1.0	0	E± Pa+	E±	0	E+±	E±	0	2.0	0	2.5	3.0	3.0	2.0
16 *BADC*	E+	E+	E±	E±	E++ Pa±	E+ Pa+	E± Pa±	3.5	2.0	E+	E+	E±	E+	E++	E±	E+	3.0	0	3.0	3.0	5.5	3.0
17 *BCDA*	0	E±	E±	.....	E+ Pa+	E± Pa±	.....	1.5	1.5	0	E±	E±	.....	E± Pa±	E± Pa+.	.....	1.0	1.5	2.0	3.5	3.0	2.5
18 *BDCA*	0	E±	E±	E±	E± Pa±	Pa±	Pa±	0.5	1.5	0	E±	E±	E±	E+ Pa++ Pu+	E± Pa+	Pa±	1.5	3.5	3.0	5.5	2.0	5.0
19 *CADB*	0	0	0	0	E+++±	0	0	2.5	0	0	E±	0	0	E++	0	0	2.0	0	2.0	2.0	2.5	2.0
20 *CBDA*	E±	0	0	0	E+ Pa±	E+	E±	2.5	0.5	E±	E±	0	0	E+± Pa±	E±	E±	2.5	0.5	3.0	2.0	3.0	3.0
21 *CDBA*	E±	E± Pa±	E±	0	E++	E+	E±	3.5	0	E±	E± Pa±	E±	0	E++	E±	0	2.5	0	2.0	2.5	3.5	2.5
22 *DACB*	E±	0	0	0	E+ Pa±	E± Pa±	Pa±	1.5	1.5	E±	0	0	0	E± Pa±	E± Pa+	E± Pa+	1.5	2.0	3.5	5.5	3.0	3.5
23 *DBCA*	0	0	0	0	E± Pa++ Pu+	Pa+±	Pa+±	0.5	5.0	0	0	0	0	E± Pa++ Pu+	Pa++ Pu±	E± Pa++	1.0	6.0	4.5	7.0	5.5	7.0
24 *DCBA*	0	E±	E±	E±	E+±	E±	E±	2.5	0	0	E±	E±	E±	E+±	E±	E±	2.5	0	2.0	1.0	2.5	2.5
	12.5	.....	.....	.....	.....	.....	.....	93.5	88.5	14.0	.....	.....	.....	.....	.....	.....	94.0	100.5	186.0	206.5	182	194.5
								182 = C									194.5 = D					

TABLE II

NUMERICAL VALUES (N.V.) OF IRRITATION PRODUCED BY FOUR BRANDS OF ADHESIVE PLASTER

Subjects, Days	A					B					C					D				
	24 Male		24 Female		Total	24 Male		24 Female		Total	24 Male		24 Female		Total	24 Male		24 Female		Total
	NVE	NVPa	NVE	NVPa	TNV	NVE	NVPa	NVE	NVPa	TNV	NVE	NVPa	NVE	NVPa	TNV	NVE	NVPa	NVE	NVPa	TNV
Patches:																				
7	7	7	6	3.5	23.5	8	5.5	6	3	22.5	7.5	7	4.5	3.5	22.5	8.5	6.5	6	3	24.0
9	7.5	1.5	5.5	2	16.5	10	1.5	5.5	0.5	17.5	9	2.5	5.5	1.5	18.5	9.5	0.5	5.5	0.5	16.0
11	6.5	1	3.5	1	12.0	7.5	1.0	3.5	0.5	12.5	6.5	0.5	3.5	1.0	11.5	7	0	4.0	0.5	11.5
TNV—48 subjects.....					52.0					52.5					52.5					51.5
Strappings:																				
7	29	21.5	26.5	13.5	90.5	19	27	26.5	19	91.5	24	24.5	25.5	13	87.0	26	23.5	26	17.5	93.0
9	19	17.5	7	11	54.5	19	21.5	9	18	67.5	15	18.5	9.5	11.5	54.5	17.5	19.5	7.5	17.5	62.0
11	14	11	5	11.5	41.0	13	13.5	8.5	12.5	47.5	12.5	11.5	7	9.5	40.5	11.5	11	5.5	11.5	39.5
TNV—48 subjects.....					186.0					206.5					182.0					194.5

between males and females. The amount of irritation in evidence at any one reading in any subject is indicated. In Table III are compared the TNV of patch tests with the TNV of strappings for each adhesive in the entire group of forty-eight subjects.

TABLE III
COMPARISON OF TNV

	Patches			Strappings		
	24 Male	24 Female	48 Total	24 Male	24 Female	48 Total
A	30.5	21.5	52.0	112	74.0	186.0
B	33.5	19.0	52.5	113	93.5	206.5
C	33.0	19.5	52.5	106	76.0	182.0
D	32.0	19.5	51.5	109	85.5	194.5

The TNV for strappings were as follows: *A*, 186.0; *B*, 206.5; *C*, 182.0; *D*, 194.5. It is obvious that the irritations produced by the brands of adhesive plaster varied very little. The highest TNV in any one subject, namely 8.5 for *A*, 10.5 for *B*, 8.0 for *C*, and 10.5 for *D* occurred in a porter, age 31 (2, male, Table 1). The lowest TNV, namely 1.0 for *A*, 1.0 for *B*, 0 for *C*, and 0 for *D* was found in an aide, age 50 (4, female).

The TNV for the 7-day patch tests were as follows: *A* 52.0; *B*, 52.5; *C*, 52.5; *D*, 51.5. There was essentially no difference in the final values. The TNV for the two-day patch tests (left thigh) were as follows: *A*, 17.5; *B*, 15.0; *C*, 12.5; *D*, 14.0. (Table 1.)

An attempt was made to correlate those facts obtained from the history or examination of the subjects with the experimental results just noted. In regard to age, the males ranged from 19 to 64 years, most being between 20 and 35 years. The females ranged from 19 to 50 years, most of them between 20 and 30 years. Inasmuch as the subjects were mainly young adults, it was not possible to compare age groups.

The female subjects showed smaller TNV than the males, e.g., the patches in the former varied from 19.0 to 31.5 while in the latter these values were 30.5 to 33.5. The TNV for the strappings in the female

group ranged from 74.0 to 93.5 while in the male subjects these readings varied from 106.0 to 113.0. It seemed to the writer that the work done by the men, most of them porters and orderlies, was a factor in explaining this difference in values.

Twenty-five of the forty-eight subjects had had prolonged contact in the past with adhesive plaster, in strapping of ankle, back, chest, or laparotomy, etc. However, it was not possible to correlate these contacts with the results obtained in this study. For example, an elevator operator, 20 years of age, who had had a clavicle strapping eight years before for a period of six weeks, an ankle strapping four years before for two weeks, and an appendectomy dressing one year before, gave TNV readings of 4.0 to 6.0, which are average readings for the entire group (10, male). However, the subject giving the highest TNV, 8.5 to 10.5, had never previously had any prolonged contact with adhesive (2, male).

There was no correlation with personal or family history of atopy. One subject (11, male) with eczema of the ears in childhood gave the fairly low TNV of 1.5 to 4.5. Four subjects with occasional hives, and three with a positive family history of allergy did not reveal any abnormal findings.

In two subjects (22, male and 8, female) who had had poison ivy the TNV were from 2.0 to 3.5 and 3.5 to 5.0, respectively. One subject (18, female) who had had a recurring dermatitis of various portions of the body for ten summers past, gave TNV of 2.0 to 5.5. These were all average values.

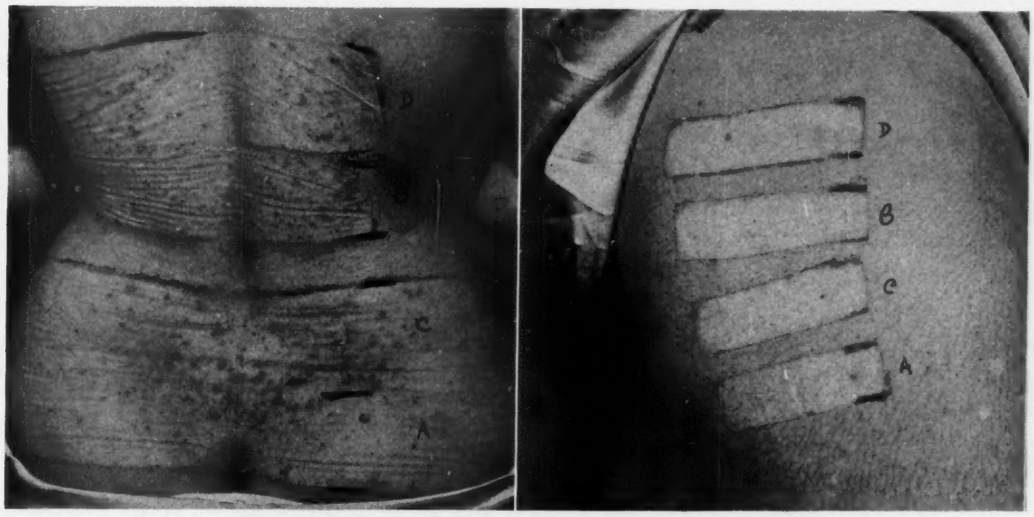
There was no correlation between the presence of plaster irritation and the color of the hair in the subject. Areas of skin covered by hair did not show more irritation than did areas of skin without hair, though more subjective discomfort was at times present.

It is commonly believed that the fairer the skin, the greater the adhesive plaster irritation. Seeliger[4] pointed out that subjects with light skin and blond hair reacted most, while those with strongly pigmented skin and dark hair reacted least. The present study, however, did not give evidence of any general relationship between the shade of skin and degree of irritation. For example, a 21 year old subject with very fair skin and light red hair gave a TNV of 2.0 to 2.5 (3, female, Fig. 4), while a 22 year old subject with black hair and a medium to dark shade skin gave TNV of 4.5 to 7.0 (23, female, Fig. 5A); also a 20 year old subject with black hair and dark skin had TNV of 5.5 to 8.5 (14, male). In fact, the strongest irritation was often found among the dark skinned.

Each subject was tested for dermagraphism by stroking the skin between the scapulae with the edge of a tongue depressor. The degree of erythema ranged from ± to +++. In general the erythema found on removal of the patch or strapping was either the same or slightly greater in degree than that shown by the stroke test. Minimal amounts of whealing (U) were produced in only four subjects, who did not as a group show more irritation than the others. The stroke reaction, moreover, bore no relation to the amount of itching or discomfort due to the strappings.

Other findings not falling into the general headings just discussed are worth mentioning. The height of skin reaction was present during the first twenty-four hours after removal of the plaster, the irritation subsiding rapidly thereafter. Table 11 shows that the TNV are less on the ninth than on the seventh day, and least on the eleventh day. In two instances, however, there was more irritation at some sites on the ninth than on the seventh day, the irritation subsiding as usual thereafter (2 and 12, female). In addition, where papules were numerous, pustules were usually scattered among them (10, male). As a rule the pustules regressed within forty-eight hours of their appearance, becoming smaller in size. The strongest papulopustular eruptions seemed to occur in those individuals whose skin showed excessive oiliness, the presence of comedones, or evidence of old acne (9, 14, and 20, male).

The marked difference in some subjects between TNV for patch test and for strappings is particularly striking where the irritation from the latter was the greatest. In subject 17, male, the TNV for patch test was 0 and for strapping 1.5 to 7.0, and in subject 23, female (Fig. 5A and B), the values were 0 and 4.5 to 7, respectively.



A B

FIG. 5. A and B. Subject No. 23, female, with dark skin. Shows marked difference in same subject in irritation following removal of seven-day strappings (TNV 4.5 to 7.0) and of seven-day patch tests (TNV = 0).

In many instances the adhesive plaster at the end of the seven day period of strapping showed a punctate mottling (Fig. 6), the dark spots corresponding to small plugs of fatty material which had been pulled away from the openings of the sebaceous glands of the skin by the sticky adhesive mass. This is an evidence that oily secretions from the skin are retained under the adhesive plaster.

DISCUSSION

A forty-eight-hour patch test with specimens of four standard commercial brands of adhesive plaster on forty-eight normal male and female subjects was negative for a reaction signifying allergic dermatitis due to adhesive. In fact should any of these subjects have been specifically sensitive, a contact of twenty-four hours or less would have been more than adequate to elicit a typical reaction. These forty-eight subjects tolerated a 7-day strapping to the back and chest with relatively little discomfort. All subjects, however, showed varying degrees of reaction to the four brands of adhesive plaster used in the strappings. This irritation lacked the clinical appearance of a specific dermatitis (papules, infiltration, vesicles). Moreover it began to subside rapidly within twenty-four hours of removal of the plaster, in contrast to the in-

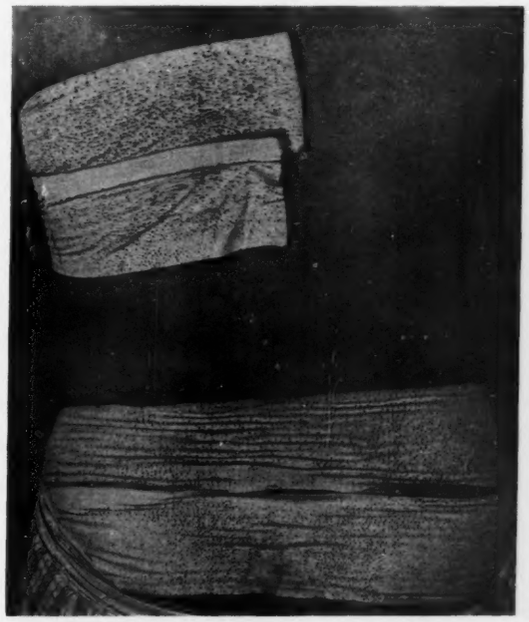


FIG. 6. Punctate mottling of adhesive plaster produced by oily secretions from sebaceous glands of skin.

crease in intensity of reaction which occurs in a specific dermatitis.

The difference between TNV of 51.5–52.5 for the seven day patch test and 182–206.5 for the clinical strappings can be explained by factors introduced when a large area of skin is covered and put under tension by a relatively impermeable foreign membrane: retention of sweat and oily secretions of the skin; maceration by friction; skin infection; chemical changes in the skin; trauma to skin capillaries, etc.

While the subject of contact dermatitis in general cannot be discussed in any detail in this communication, it will suffice here to mention a few criteria for establishing a diagnosis of allergic dermatitis due to adhesive plaster. They are (*a*) the application of adhesive plaster for twenty-four hours or less, producing a reaction localized to the site of contact and characterized by intense erythema, edema of the skin, and tiny or larger vesicles; rarely the reaction may spread beyond the limits of contact; (*b*) during the first few days after the removal of the plaster, the reaction usually becomes more intensified; (*c*) typical specific reactions are obtained by patch test with the known excitants in plaster mass, namely resin and rubber, and possibly others; (*d*) a history is obtained in many instances of contact dermatitis in the past due to other excitants. There is a low incidence of this condition in the general population. These criteria must be considered before one can rightfully make a diagnosis of a specific (allergic) dermatitis due to adhesive plaster.

In the present study not a single instance of specific dermatitis was encountered. Most subjects showed some degree of nonspecific irritation. No one brand of adhesive plaster seemed to be more productive of irritation than any other brand. Thus it was not possible to substantiate the claims of one manufacturer of adhesive plaster, either by actual test or by definition, that his product was less irritating and produced fewer allergic reactions than others.

CONCLUSION

The factors producing adhesive plaster irritation were studied by comparing in forty-eight subjects the effects on the skin of actual clinical strappings with the effects produced by patch test applications with the same adhesive plasters. Four standard commercial brands were used, (Bauer and Black formula 87, Bay, Johnson & Johnson "Z.O.," and Seamless Rubber). Not a single instance of specific dermatitis was encountered. It was determined that there was very little difference in the degree of irritation produced by each of the four brands. It is apparent that a certain amount of nonspecific irritation by adhesive plaster cannot be avoided. The distinction between specific and nonspecific dermatitis due to adhesive plaster is pointed out.

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THE USE OF NEOSYNEPHRIN HYDROCHLORIDE IN MAINTAINING BLOOD PRESSURE DURING SPINAL ANESTHESIA*†

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ONE of the major problems in spinal anesthesia is the constantly falling blood pressure. Epinephrine and ephedrine, especially the latter, have been used to preserve its stability. Both are sympathomimetic drugs and raise the blood pressure primarily by a vasoconstriction. With therapeutic dosage they increase the efficiency of the heart and cause an increase in the cardiac rate. The main objection to both during spinal anesthesia is their stimulating effect on the central nervous system. Epinephrine, particularly in moderately large doses, also increases the irritability of the heart and predisposes it to various types of arhythmia. Ventricular fibrillation and pulmonary edema have been reported after its use.[7,8] Ephedrine also stimulates the central nervous system and may produce palpitation, throbbing of the head and even a reversal of its original action.[7] Lastly, epinephrine is not well suited because its action is of such short duration.

Neosynephrin hydrochloride is a synthetic drug resembling epinephrine and ephedrine both structurally and pharmacologically. Figure 1 shows that the essential difference between epinephrine and neosynephrin is the additional hydroxyl group contained in the benzene ring of the former. This difference may account for the stability of neosynephrin hydrochloride, which may be sterilized by boiling.

As would be expected from its close relationship to epinephrine and ephedrine, neosynephrin also causes a rise in blood pressure as effectively as ephedrine without stimulating the central nervous system and without a resulting tachycardia. On the contrary, neosynephrin, when injected subcutaneously in normal subjects produces a definite bradycardia.

Brunner and de Takats,[5] in their series of 163 cases of spinal anesthesia using neosynephrin hydrochloride to stabilize blood pressure, found that no anxiety or nervousness was produced. Also they observed that neosynephrin was just as effective as ephedrine in raising or maintaining a falling blood pressure. The action of neosynephrin is manifest even after repeated doses. Johnson[3] gave twenty-two injections of neosynephrin in therapeutic dosage to a patient in postoperative shock and each time produced a rise in blood pressure. The intervals between injections varied from twenty to twenty-five minutes. This patient went on to recovery.

TABLE 1

Hemorrhoidectomy	9
Colostomy	9
Rectal fistulectomy	8
Herniorrhaphy	5
Exploratory laparotomy	4
Repair of colostomy	4
Incision of rectal abscess	2
Hemorrhoidectomy and fistulectomy	2
Epididymectomy and orchidectomy	1
Cystostomy	1
Abdominal perineal resection (cancer of rectum)	1
Perineal resection of rectum	1
Excision of anal ulcer	1
Excision of rectal polyp	1
Excision of pilonidal cyst	1

Johnson also states that the fatal dose of neosynephrin hydrochloride, as determined by intravenous injections in dogs, is about 250 mg. per Kg. The fatal dose of ephedrine is roughly one-third and that of epinephrine one-forty-seventh of that amount.[1,3]

* From the Proctologic Service, Atlantic City Hospital.

† Read before the Proctologic Society, Graduate Hospital, University of Pennsylvania, December 13, 1939.

In our series of fifty cases of spinal anesthesia using neosynephrin hydrochloride as a vasoconstrictor, we were impressed by

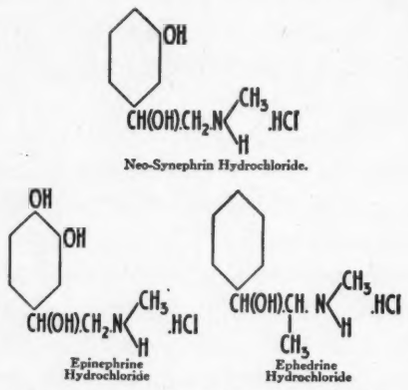

FIG. 1. Demonstrating the similarity between neosynephrin, epinephrine and ephedrine hydrochlorides. As shown by their structural formulae.

the ready and repeated response of the blood pressure; the bradycardia and the lack of arhythmia; and the absence of nervousness or anxiety on the part of the patient. The cases reported are mainly from the proctologic department, but several cases of serious illness from the surgical and urological departments are included. (Table 1.)

In the fifty cases there were seven postoperative deaths. One patient, 73 years of age, with a history of previous auricular fibrillation, died on the eighth postoperative day of acute cardiac decompensation. One died of coronary occlusion on the seventh postoperative day. Two patients died with generalized peritonitis. Both had strangulated herniae for more than twenty-four hours before operation and one had a ruptured gangrenous appendix contained in the hernia sac. One patient with cancer of the colon died on the seventeenth postoperative day; at operation she was deemed beyond surgical aid and had been immediately closed up. Two patients died of peritonitis following operations for relief of intestinal obstruction. Both were markedly debilatated, anemic—poor operative risks, one because of cancer of the colon with obstruction and widespread metastases, and the other because of lymphopathia venereum with necrosis and abscess formation extending up and including portions of the descending colon.

In all of our cases we used neocaine and pontocaine for anesthesia, either singly or together.

In 50 per cent of the cases the level of anesthesia extended to the umbilicus. In 22 per cent the level extended to a point midway between the umbilicus and the costal margin, and in 28 per cent the level extended to the costal margin or higher.

The minimum dosage in the series was 60 mg. of neocaine dissolved in 2 c.c. of spinal fluid. The average dosage was 95 mg. of neocaine dissolved in 3.5 c.c. of spinal fluid, with the maximum 75 mg. of neocaine and 17 mg. of pontocaine in 4 c.c. of spinal fluid. In ten cases neocaine and pontocaine were given together and in two cases pontocaine was given alone.

Preoperative medication consisted of 3.5 gr. of sodium allurate the evening before the day of operation, repeated two to three hours before operation. One-half hour before operation $\frac{1}{6}$ gr. of morphine sulfate and $\frac{1}{150}$ gr. scopolamine hydrochloride were given. In the rectal cases, the scopolamine was omitted. With this procedure, the patients were generally sleeping when brought to the operating room and seldom felt the spinal puncture or knew the operation was in progress.

The neosynephrin hydrochloride was mixed with 1 per cent novocaine and given subcutaneously and intramuscularly over the site chosen for the spinal puncture. One half c.c. of 1 per cent neosynephrin hydrochloride was the initial dosage in all cases of this series. The administration of the spinal anesthesia followed in five to ten minutes. Blood pressure and pulse were taken when the patient reached the floor, immediately after the spinal anesthesia had been given, and every five minutes thereafter.

The average initial rise in blood pressure, approximately 20 points, occurred ten to fifteen minutes after the injection of the neosynephrin and lasted twenty-five to

thirty minutes. In one case the initial rise was 75 points.

The average blood pressure was higher during the operation than the average normal blood pressure preoperatively. In only ten cases was the neosynephrin repeated during the operation. For readministration, ¼ c.c. of the 1 per cent solution was given. It was repeated once in seven cases, twice in two cases, and three times in one case.

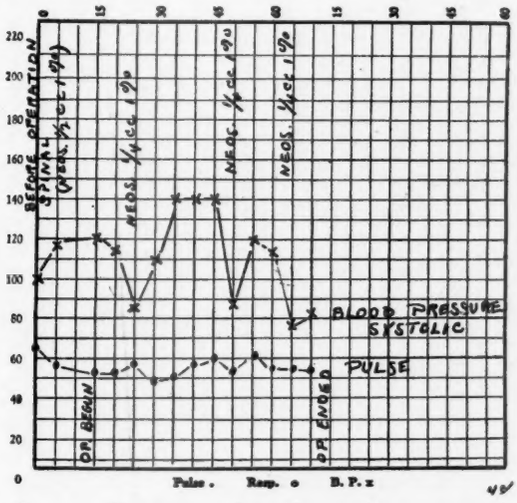

FIG. 2. Demonstrating the maintenance of blood pressure above the preoperative level during perineal resection of the rectum. Pontocain, 15 mg.; neocain, 75 mg.

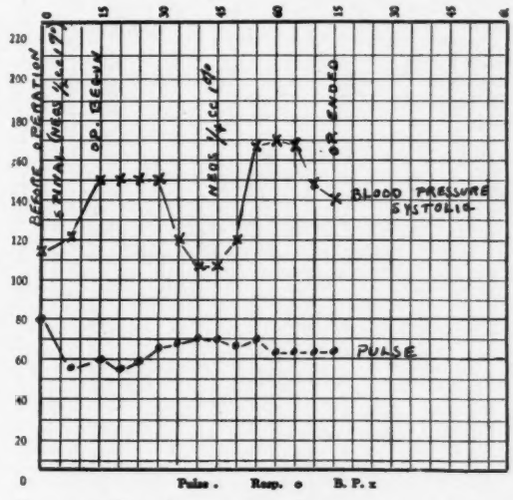

FIG. 3. Showing repeated response to neosynephrin and bradycardia. During excision of upper portion of sigmoid and colostomy. Pontocain, 15 mg.; neocain, 75 mg.

The pulse was slower in 56 per cent of the cases during operation than the average preoperatively. However, we feel that if we had attempted to maintain the blood pressure at a higher level by more frequent injections of neosynephrin, the bradycardia would have been more evident, since we noted that the bradycardia occurred as the blood pressure rose and tended to disappear as it fell. Tachycardia definitely did not occur. The average pulse rate was 79.

SERIES OF FIFTY CASES OF SPINAL ANESTHESIA USING NEOSYNEPHRIN TO MAINTAIN BLOOD PRESSURE

Average preoperative blood pressure	126
Average blood pressure during operation	125
Average preoperative pulse	81
Average pulse during operation	79

The bradycardia has been explained in various ways. Lorthan and Oliverio[4] state that it is a compensatory reaction following the increased stroke volume of the heart. It may also be a compensatory slowing due to stimulation of depressor fibers from the carotid sinus and the aortic arch. Brunner and de Takats[5] show an electrocardiogram of a patient whose heart rate dropped from 58 to 40 following neosynephrin; simple bradycardia is evident.

We feel that the compensatory mechanisms are not strong enough to produce such a marked lowering of the heart rate over a prolonged period. Also, a case is cited in which the bradycardia outlasted the rise in blood pressure by two hours. From our own observations we are inclined to believe that neosynephrin has a direct depressing action on the heart, perhaps similar to the action of quinidine. If this is so, then the rate of impulse formation in the sino-auricular node would be slowed and a simple bradycardia would result.[8] More work will have to be done before the etiology of the bradycardia can be explained. The action of neosynephrin on the refractory period and the conductivity in the bundle of His should throw some light on the subject.

In the matter of central nervous system stimulation, we noticed no untoward effects. None of the patients complained of feeling anxious or nervous during or after the operation. Our preoperative medica-

tions may have masked these symptoms if they were present, but it may be noted that none complained of palpitation, throbbing

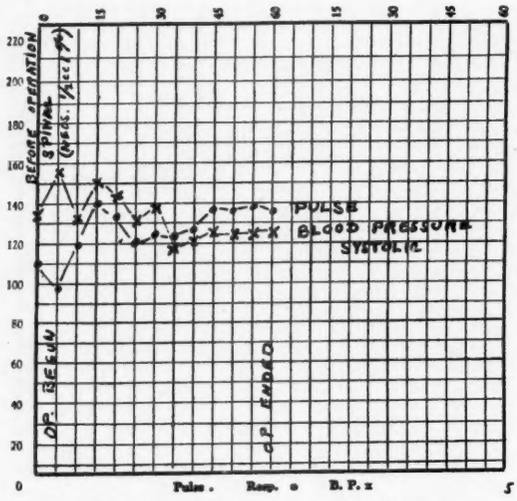

FIG. 4. Demonstrating stability of blood pressure with a heavy and high spinal. Pontocain, 12 mg.; neocain, 100 mg.

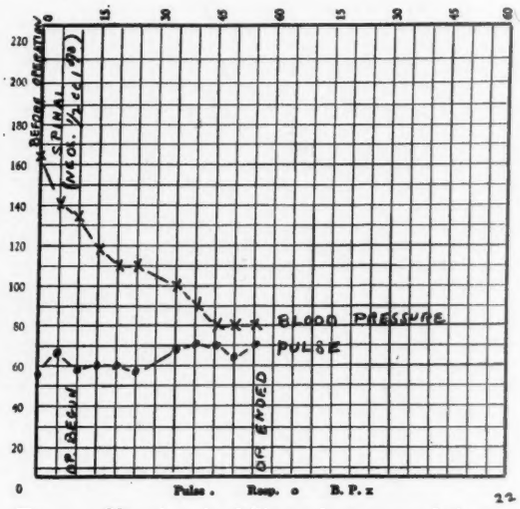

FIG. 5. Showing inability of neosynephrin to raise blood pressure in presence of toxic shock.

of the head or other symptoms produced by closely allied drugs, such as epinephrine or ephedrine.

Figure 2 demonstrates the rise in blood pressure and the bradycardia. Neosynephrin hydrochloride was repeated three times, each dose being ¼ c.c. of the 1 per cent solution. Each time a definite rise of blood pressure occurred, although the pulse remained fairly stable at the lowered rate achieved after the initial injection. In this patient a perineal resection of the rectum was performed under spinal anesthesia of 75 mg. of neocaine and 15 mg. of pontocaine.

In Figure 3 the blood pressure and pulse are shown during an operation for excision of a carcinoma of the sigmoid with colostomy. The patient was a 67 year old male considered only a fair operative risk. The level of anesthesia was above the costal margin. The anesthetic consisted of 15 mg. of pontocaine and 75 mg. of neocaine in 4 c.c. of spinal fluid. The average blood pressure during the entire operation was higher than the preoperative pressure, although the neosynephrin was repeated only once. The bradycardia is also well demonstrated in this case. After this patient returned to the ward his blood pressure dropped to 112 and then rose steadily until three hours after operation, when it was back to the original preoperative level. The pulse rate remained at 56 until two hours postoperative at which time it began to rise.

Figure 4 shows the course of a patient who had a cystostomy performed for the removal of bladder calculi. Only the initial injection of neosynephrin hydrochloride was given. The average blood pressure during the operation was lower than the original preoperative pressure by only three points. The maintenance and stability of the blood pressure is striking, in view of the fact that the patient received 100 mg. of neocaine and 12 mg. of pontocaine. Bradycardia was exhibited in this case only after the original dose of neosynephrin. As soon as the blood pressure began to drop the pulse rose and remained high.

Neosynephrin, as shown by Johnson, will not raise the blood pressure in cases where there is loss of blood volume by hemorrhage or where a peritonitis exists. The latter condition he terms a type of toxic shock. He shows that the pressor effect is lacking when the fluid volume is low. It might appear from this that the action of neosynephrin would be an excellent indicator of

the blood volume of the patient during operation in the absence, of course, of toxic shock.

Figure 5 is the graph of a patient previously mentioned who was operated upon for a strangulated indirect inguinal hernia. At operation a ruptured gangrenous appendix was found enmeshed in the hernia sac, and a generalized peritonitis was disclosed. As can be seen, neosynephrin hydrochloride was unable to raise or maintain the blood pressure, which steadily fell from 160 to 80. The patient died on the fourth postoperative day.

SUMMARY AND CONCLUSIONS

Neosynephrin hydrochloride is an effective aid in maintaining the stability of blood pressure during spinal anesthesia. A definite bradycardia generally occurs after its administration. Deleterious effects such as arhythmia, palpitation, anxiety or nervousness were not manifest if neosynephrin was given in therapeutic doses. The margin of safety of neosynephrin is greater than that of epinephrine or ephedrine. It is not effective in cases where there is loss of blood volume or shock caused by toxic conditions such as peritonitis. Until its exact action on the heart has been proved, it is best to use small doses or abandon its use entirely in cases which present serious cardiac pathology.

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PREVENTION AND TREATMENT OF LATE SEQUELAE IN CORRECTIVE RHINOPLASTY*

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PHYSICIANS in all branches of medicine are consulted with increasing frequency about the possibilities of corrective rhinoplasty. To answer such inquiries authoritatively, they must be familiar with the sequelae which may follow imperfect nasal repair and understand the factors which enter into their prevention and treatment. This paper will discuss late structural sequelae confined to the nose itself. It will not include repair of partial or total loss of nose, except for post-surgical complications.

GENERAL CONSIDERATIONS

It is logical to start with the qualifications of the rhinoplastic surgeon. He must have a thorough training in rhinology to recognize local pathology and to ensure adequate endonasal vision and proper handling of tissues in the nasal cavities. He must also have an understanding of the purely plastic factors involved in reconstruction of the nose.

There is also a definite artistic canon which should guide the rhinoplastic surgeon. Esthetically, the nasal bridge should form a 30 degree angle with the forehead-chin line. The degree of elevation above the ideal profile line indicates the amount of bone and cartilage to be removed from the dorsum. Preoperative study of the patient with a photometer or profilometer helps to outline the proper facial angles and determine how much of the osteocartilaginous frame to remove or add.

According to the normal esthetic canon, the lower level of the cutaneous septum should be decidedly below the free border of the nostrils. Another important point is the length of the nose from root to tip. This should be shorter than the line extending from the root of the columella to the top of the chin. The septo-labial angle, formed between columella and upper lip, should be between 90 and 105 degrees.

Excessive shortening of the septum is one of the most frequent errors in rhinoplastic repair. It is also one of the most difficult to correct. The patient should be carefully studied preoperatively and the utmost caution exercised in shortening the septal cartilage. *It is far safer to remove too little than too much.*

Infection. The most common cause of late sequelae in rhinoplastic repair is infection. This complication can be almost entirely eliminated by preoperative precautions and proper surgical technique.

Prior to surgery, not only the nasal cavities but the entire facial skin should be carefully examined and prepared. All localized skin infections, such as acne and eczema, should be treated before surgery is undertaken, especially if lesions occur about the lip and nostrils. Special care must be taken in the preparation of excessively seborrheic skin, which is susceptible to infection. In one case a seborrheic nasal skin in a girl of 15 was overlooked until the time of operation. In spite of proper cleansing and antiseptic measures on the operating table, a slight puncture of the skin was followed by the formation of a sinus which took months to dry. Scar formation followed, requiring excision and compromising an otherwise good result.

Avoidance of unnecessary scarring is of course an essential element in the prevention of permanent sequelae. Unless cartilaginous or bony grafts must be inserted, most nasal deformities are best corrected by the endonasal route. The danger of

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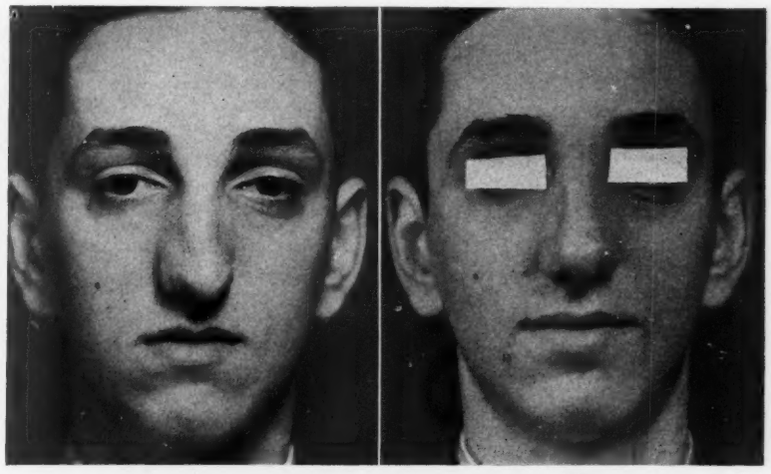
infection is slight if meticulous care is taken in the preparation of the nasal cavities.

Prior to operation the nose and accessory sinuses should be carefully examined and preoperative rhinologic treatment given when necessary. Corrective rhinoplasty is definitely contraindicated in the presence of an acute or subacute inflammation of the mucous membrane of the upper respiratory tract.

In the presence of a chronic sinus infection, corrective endonasal procedures should be postponed until proper rhinologic treatment has been carried out. As a permanent cure is doubtful in such cases, extreme caution must be employed when surgery is finally undertaken. Here columellar incision is the procedure of choice in most cases.

Even when no inflammatory process is present, the mucous membrane must be carefully prepared for rhinoplasty. Drops of 15 per cent solution of argyrol are instilled in the nasal cavities twice daily for three or four days prior to surgery. At operation, the nasal cavities are cleansed, the hairs in the nasal vestibules cut and the surrounding skin carefully disinfected.



A B

FIG. 1. Combined fracture of nose and septum with lateral deviation and subluxation of septal cartilage. *A*, boy aged 19, with nasal fracture of fifteen years' duration. Following injury, the nose was left unattended on the advice of the family physician, to wait until age of 16. The left nasal cavity was completely obstructed for fourteen years by the fractured and thickened septum. The post-traumatic disfigurement was greatly disturbing to the boy during the period of growth. Adequate first aid following injury would have prevented the external deformity and disturbance of nasal function. *B*, plastic repair by partial resection of septum with resetting of the subluxated anterior portion of septal cartilage. Bony and cartilaginous deviation corrected in a subsequent stage.

Drainage. When infection does occur, the area involved must immediately be drained through the endonasal incision. Should this fail to check the infectious process within twenty-four hours, small external incisions are made at the lower level of the infected area to promote drainage. They usually heal rapidly, leaving inconspicuous scars.

When infection occurs around autogenous transplants, the latter are not necessarily destroyed. Drainage and antiseptic treatment of the involved area permit most of them to be saved, provided the infection is localized. If a graft of foreign material like ivory is infected, however, it must immediately be removed, as healing will not otherwise take place.

Hematoma is another important factor in the production of permanent late sequelae. It may appear following wide undermining of the nasal skin without proper use of

pressure. It can be prevented by adequate postoperative use of external splints.

When a hematoma occurs, it should be evacuated endonasally as soon as possible and free subcutaneous spaces obliterated by splinting. Delay favors infection and retards normal healing of the reconstructed parts.

Skin Necrosis. Pressure, improperly applied, may in itself cause an undesirable complication, namely, necrosis of the skin. This can easily be avoided if the copper or lead splint usually used is sufficiently upholstered to prevent direct contact of the metal with the skin. This is particularly important in summer, when there is exces-

A B

Fig. 2. Nasal fracture with extensive laceration of skin. *A*, early repair done elsewhere failed to reestablish proper continuity of bone and skin. *B*, secondary repair was delayed for a number of months to allow for reestablishment of proper skin circulation. Following skin repair autogenous rib cartilage support was provided.

A B

Fig. 3. Paraffinoma of nose. *A*, woman, 35 years of age, had paraffin injected about twenty years previously to fill out a nasal depression. Except for slight redness of the skin, the paraffin gave no symptoms for ten years. Then skin in upper third of nose became thick and conspicuously discolored and a hard, adherent mass appeared. Exteriorization of paraffinoma usually indicates malignant trend and requires wide removal. *B*, the paraffinized skin and subcutaneous tissue of nose were excised and defect covered by a forehead flap. In a later stage, a rib cartilage graft was inserted to provide support for nasal bridge.

sive maceration of the skin due to heat. The repair of skin necrosis is discussed below.

Immediate resetting of fractures would prevent many malformations. This is particularly true in childhood with its many falls. Failure to diagnose and treat childhood fractures promptly may cause not merely external maldevelopment of the nose but septal dislocation, with its pathologic accompaniments. (Fig. 1.) Submucous resection does not enter into question here. We merely reset the dislocated cartilage and bone, bloodlessly, as soon as possible, prior to fibrous formation. Under no circumstances should fragments of bone or cartilage still adherent to the periosteum or perichondrium be removed, as malformation unavoidably follows.

A B

FIG. 4. Post-traumatic partial loss of skin of nasal tip. *A*, attempts were made elsewhere to improve this scar by radium and *x*-ray. Skin loss of this kind on nose must be repaired by providing the missing skin with or without subcutaneous tissues. A free skin graft would be insufficient here as the ala would remain too thin. *B*, forehead temporal flap taken along the hairline reconstructed all missing parts of tip and nostril, providing a skin which ideally matches the surrounding area.

Anesthesia. Proper anesthesia contributes to uneventful healing. In the great majority of cases, local anesthesia, by infiltration or block, is the method of choice. A basic avertin anesthesia by rectum, complemented by local infiltration with novocaine, is useful for excessively nervous individuals. As a rule, however, local anesthesia, given in association with sedatives, is effective, safe and materially shortens the period of hospitalization.

As in all surgery, *timeliness* is an important factor in the success of rhinoplastic procedures and the prevention of permanent late sequelae. Failure to undertake nasal repair at the right time is frequently responsible for deformities which subsequently require more difficult and more extensive corrective procedures. (Fig. 2.)

Nasal fractures, for example, should be corrected as early as possible, prior to organization of the fragments in a faulty position. In all injuries to the nose, especially when epistaxis occurs, fracture should be suspected and searched for by rhinologic examination and *x*-ray.

When harelip is corrected in early childhood, it is essential to correct the accompanying drooping and flattening of the nostril at the same time. Otherwise there will be a subsequent maldevelopment of the entire nose.

SPECIFIC SEQUELAE

Following imperfect rhinoplastic repair, there may be the following late structural sequelae:

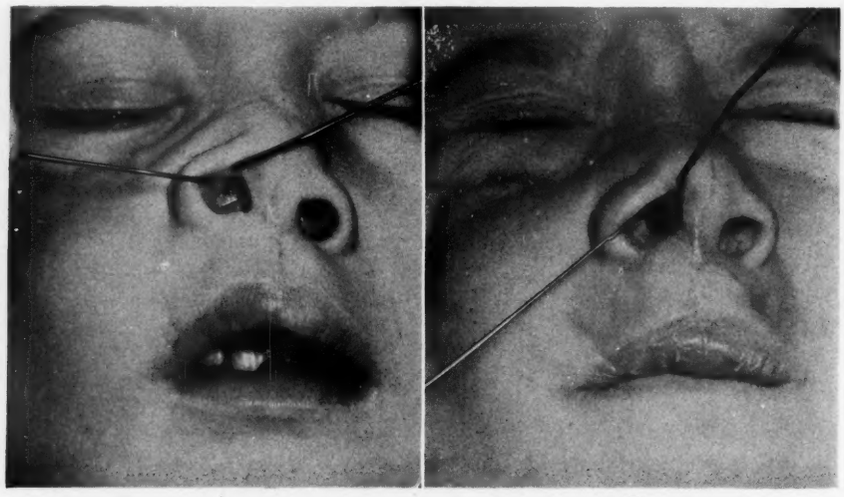
1. *Irregularities of the Bridge.* Sometimes after removal of the oversized osteo-

cartilaginous portion, particles of bone or cartilage remain subcutaneously and produce irregularities in the bridge. Left in situ, they adhere to the bony edges, producing small osteomas. Frequent cleansing of the subcutaneous space with concave rasps helps to eliminate such particles.

Improper shaping of the dorsum, with consequent irregularity of the bridge, can usually be prevented by repeated thorough examination of the operative field, either manually or by direct vision. Secondary correction is comparatively simple. Any excess is removed subcutaneously through a small endonasal incision. A limited depressed area can easily be filled out with an autogenous graft or corrected by transposition of lateral cartilages.[1]

Occasionally postoperative dorsal protuberance is due to subcutaneous scar formation which increases with the passage of time. This is the result of a keloidal tendency and has nothing to do with surgical technique. Excision of the subcutaneous fibrous tissue is often followed by a recurrence.

2. *Flatness.* The use of rasps for removal of a bony hump is a common cause of postoperative flatness of the bridge.



A B

FIG. 5. Post-traumatic endonasal fibrous stenosis in girl aged 7. *A*, the torn mucous membrane in both nasal cavities went unattended during emergency repair for lacerations of face and nose. Healing of the endonasal raw surfaces resulted in nearly complete occlusion of both nasal cavities. *B*, shows restoration of patency of the right nasal cavity following excision of scar tissue and insertion of a split graft. To avoid contraction of the graft and secondary obliteration of the cavity, a perforated, gutta percha splint was kept in the nostril for about two months, being removed at short intervals for cleansing purposes.

Sharp saws are more accurate and less traumatizing than rasps or chisels.

Flatness of the bridge is corrected by freshening the bony surface, separating the nasal bones on either side of the septum, and infracturing the frontal processes of the maxilla.

3. *Improper Narrowing.* Narrowing of the bridge is always required after the removal of a bony protuberance, whether the elevation is prominent or slight.

Faulty lateral sawing is frequently the cause of asymmetry and bony protuberance.

4. *Incomplete Setting of a Scoliotic Deformity in Midline.* Replacement of the bony nose in the midline always requires a wedge-shaped excision of bone from the frontal maxillary process on the wide lateral wall.

Simple infraction of the frontal processes is insufficient. Postoperative sustained pressure on the deviated lateral wall for

two or three hours daily by means of an appropriate unilateral splint is another important aid to centralization of the nasal dorsum.

5. *Obstruction Due to a Dislocated Septum.* Lateral deviation of the bridge is often associated with deviation and dislocation of the septum. This is usually of traumatic origin, which accounts for the thickness and even calcification of the septal or lateral cartilage. (Fig. 1.)

Postoperative sequelae are frequent in this condition because of the difficulty of moulding thickened and distorted cartilages into the desired form. To accomplish this the cartilages must be entirely freed from adhesions to the bones and their thickness reduced to a point where shaping is possible. *The dislocated septum must be reset in proper position to assure a support for the nasal tip.* Removal of the subluxated portion of the septum, which is so often done, is a grave technical error.

In this combination of bony and cartilaginous deformities, it is advisable to perform the correction in stages, unless the subluxation of the septum is slight and deviation is confined to the posterior portion. Usually two stages suffice. *The deviated and subluxated septum should be repaired prior to the bony correction.* This provides sufficient breathing space to permit the narrowing of the bony bridge and removes any mechanical obstacles to the narrowing process.

6. *Irregularities of the Nasal Tip and Nostrils.* The width of the nasal tip is largely determined by the configuration of the lower alar cartilages (outer crus). When vestibular lining is excised along with alar cartilage to narrow the tip, retraction of the nostrils frequently occurs in the form of irregular depressions. In my opinion, sacrifice of this skin lining is not permissible in most cases.

Occasionally, where the alar cartilages are markedly hypertrophic, an excess of vestibular lining may be removed, but the utmost care must be taken to ensure that the remaining lining is sufficiently large to cover the raw surface. Otherwise conspicuous retraction of the skin of the tip follows scar formation in the vestibulum. The same error is responsible for atresias in the upper part of the nostrils.

Abnormal narrowing of the nostrils may also result from adhesions between raw surfaces of the lateral wall and the septum. This can be prevented only by keeping the endonasal lining accurately in place, either with sutures or by endonasal packing, preferably the former.

7. *Sequelae Due to Incorrect Analysis of Causative Factors.* Unfortunate sequelae to the repair of depressed deformities are often due to incorrect analysis of the elements producing the depression. Depressed deformities are caused by either lack or misplacement of supporting nasal structures. Loss of bony or cartilaginous support necessitates a graft from the outside. Where the deformity is due to dislocation or displacement of the nasal structures, which is generally the case in trauma, the fractured and misplaced bones and cartilages can often be rearranged in normal position, permitting reconstruction of the fallen parts without the introduction of extraneous plastic material. Sometimes both procedures must be combined.

8. *Sequelae Due to Use of Unsuitable Material.* When a graft from the outside must be introduced, complications result if the material employed is not suited to the desired purpose.

A. Rib Cartilage. Autogenous rib cartilage is generally conceded to be the best autoplastic supporting material. (Fig. 2.) It has good tensile strength and does not as a rule become absorbed unless markedly calcified. Bending is the chief drawback to the use of rib cartilage when a straight support is required, but this can often be corrected.

B. Septal, Auricular and Alar Cartilages. Septal cartilage is prone to absorption because of its abundance of yellow, elastic fibers. It is sometimes useful in small depressions, however, especially when it is readily available during submucous resection. Upper and lower lateral cartilage, too,

is useful only for limited depressions and when easily available.

Auricular cartilage is usually contraindicated because of its curvatures. It has its uses, however, in the reshaping of curved areas like the nostrils.

C. "Pickled" Cartilage. During the last few years many surgeons (notably Pierce and O'Connor[2]) have been experimenting with so-called "pickled" cartilage taken from the cadavers of individuals free from infectious disease. This cartilage, preserved in alcohol or methylate, has proven one of the best substitutes for autogenous cartilage. It has the great advantage of always being available. We have used it on many occasions with complete satisfaction. The experimental work of Peer in this regard is of great interest.[3]

D. Bone Graft. Used alone, bone used to be considered inappropriate as a supporting graft for the nose. In recent years, however, it has been emphasized that bony grafts taken from the crest of the ilium give highly satisfactory nasal support.[4]

E. Ivory. The value of ivory as a nasal implant is doubtful. Years ago I wrote on the possibilities of ivory, a dead organic substance, as a *substitute* plastic material for nasal support where cartilage or bone could not be used.[5] It is unfortunate that those articles of fourteen years ago should still be used to justify the indiscriminate use of ivory as a nasal support, for it has certain serious disadvantages: (1) Ivory is easily infected. When this occurs it must immediately be removed. (2) It may produce chronic skin discoloration and other localized reactions. (3) It may give rise to pressure necrosis years after the insertion of the implant, although it has been in situ in some of my patients for over twelve years without untoward effects.

In my opinion, and judging by the experience of a number of qualified observers during the last few years, "pickled" cartilage is a much more reliable substitute.

F. Paraffin. Paraffin is included in this list in a wholly negative sense—to warn of the dangers inherent in its use whether it is administered in liquid or solid form. Strangely enough, in spite of practically unanimous condemnation by reputable specialists in this field, injections of paraffin continue to be used to fill out various types of defects. (Fig. 3.)

Once the skin becomes infiltrated with injected paraffin, it undergoes certain pathologic transformations necessitating excision of the affected skin together with the infiltrated subcutaneous tissue. Simple subcutaneous removal of the paraffinized structures may suffice if extensive changes have not taken place in the skin.

G. Sequelae Due to Loss of Nasal Skin. As previously mentioned, improper application of pressure may be followed by skin necrosis. This is mostly repaired by free skin grafts, which must match the surrounding facial skin in color and texture. The upper eyelids and the region behind the ear furnish the most suitable material in this respect. Skin from distant areas, such as the chest, abdomen and arm, should not be used except as a last resort; the color is always unnatural.

Where there is a loss of subcutaneous tissue as well, and greater thickness is required than the free skin graft supplies, a pedicle flap is indicated. The tubed forehead flap (Fig. 4) is the most suitable because of its color, with flaps from the neck or side of the nose as second choice.

If skin is to be used endonasally to relieve atresias caused by loss of mucous membrane or vestibular skin, a split or a full thickness graft is preferable to the thin epidermal (Thiersch) graft because of the latter's tendency to contract and thereby reproduce the obstruction. (Fig. 5.)

SUMMARY

1. Corrective rhinoplasty is one of the most frequent procedures in present-day reparative surgery. Late sequelae are due to many factors, a large percentage of which can and should be prevented. Impor-

tant causative factors are: (1) infection; (2) faulty surgical technique; (3) lack of proper planning, with inattention to artistic considerations.

2. In post-traumatic deformities failures could often be prevented if the displaced and dislocated parts of the nasal frame were reset in normal position without the addition of outside supporting material. Narrowing of the bony bridge, transposition of the upper and lower lateral cartilages and resetting of the subluxated septum are steps which, when properly carried out, assure an optimum end result.

3. Autogenous cartilage is the substance of choice for nasal support. "Pickled cartilage" is a good substitute.

4. Free grafts for repair of skin losses should be taken from a nearby area in order to match the surrounding skin as closely as possible in color and texture.

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THE TREATMENT OF SUPPURATIVE GENERALIZED PERITONITIS WITH ALCOHOL

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IN 1923, the idea of treating intra-abdominal suppurative areas by swabbing with 70 per cent ethyl alcohol was first practically applied by Behan during an operation for acute suppurative peritonitis. In this case the appendix had ruptured and free pus was present in the peritoneal cavity. On culture and microscopic examination, the pus showed Gram-negative bacilli and Gram-positive diplococci. About 20 c.c. of 70 per cent ethyl alcohol was swabbed into the area from which the appendix had been removed. The patient was discharged from the hospital in fifteen days, about seven days earlier the average period of hospitalization at that time in this type of case. Several other cases of a similar nature were successfully treated in the same manner.

Encouraged by the good results which were obtained in the treatment of localized peritonitis by the application of alcohol to the involved area, Behan began to use 70 per cent alcohol as an intra-abdominal lavage in suppurative peritonitis. This was first done in 1926 in a case of acute gangrenous appendicitis resulting in acute suppurative peritonitis. A culture from the free pus in the peritoneal cavity showed *B. coli.*

Due to inherent conservatism and the inertia of habit, although its beneficial and life-saving effects were apparent, intra-abdominal lavage with 70 per cent alcohol was not at once adopted as a means of treatment in all cases of suppurative peritonitis. However, the results of treatment in the cases in which it was used were so convincing that it was finally adopted as a routine procedure. Since its adoption we have had an astonishingly low mortality in our suppurative peritonitis cases. One statistical study is based primarily upon cases of acute exudative appendicitis and suppurative peritonitis, treated in St. Joseph's Hospital over a period of three years. These figures are compared with a series of cases treated in the same hospital from 1920 to 1933. In this period there were forty-four cases of acute generalized suppurative peritonitis in which alcohol was not used as an intra-abdominal lavage. Of these, twenty-two died, a mortality of 50 per cent. In the same period, forty-two patients with acute generalized suppurative peritonitis were treated in an identical manner with, in addition, intra-abdominal lavage with 70 per cent ethyl alcohol. We added to these forty-two cases four similar cases in other hospitals. In all, in the forty-six cases, two died, a mortality of 4.3 per cent.

Since 1930, because of convincing belief in its effectiveness, we have routinely used intraperitoneal lavage with 70 per cent ethyl alcohol in all cases of peritonitis at operation. When the abdomen has been opened, if free fibrinous fluid or pus is found in the peritoneal cavity, a culture is taken. This is immediately followed by the introduction of 100 to 200 c.c. or more of 70 per cent ethyl alcohol into the abdominal cavity. The amount may be increased to a degree sufficient to fill the walled off and localized abscess cavity; or, if a generalized peritonitis is present, to flood the free peritoneal cavity. In every instance, of generalized suppurative peritonitis the abdominal wall on either side of the incision is elevated by retractors and sufficient alcohol is introduced to fill the peritoneal cavity com-

pletely, so that the fluid level is flush with the margin of the incision. The alcohol is allowed to remain in situ for a few minutes and then is siphoned off by a suction apparatus.

If the contents of the abdominal cavity are particularly foul and there is a large quantity of serofibrinous exudate, alcohol is alternately poured into the abdominal cavity and siphoned away until the return flow is clear. Apprehension over using this method should be negligible for there is little or no danger from the introduction of too much alcohol, and even when large quantities are used, no untoward results are to be expected. After the free alcohol has been siphoned out, abdominal protective packs are so arranged that the entire area involved in the inflammatory appendiceal reaction is isolated as completely as possible, from the remainder of the abdominal cavity.

The appendix is then sought and is removed, since it is the focus of infection. Some surgeons lean to the conservative idea that in cases of peritonitis accompanying appendicitis, the appendix should be allowed to remain until a more favorable time for removal. This idea which at one time was universal is now generally discarded so that the majority of surgeons now believe that a ruptured appendix should be removed immediately, although some still hold that, in a small percentage of cases, conservative treatment and delay in operation offer the patient the best chance of recovery. If, the peritonitis is the result of a perforated viscus or other cause, rather than of an inflamed appendix, the cause of the peritonitis is sought and eliminated.

During the course of the operation, the involved areas of the abdominal cavity exposed in the incision, are repeatedly flushed with alcohol, but no excessive quantity of alcohol is permitted to remain for more than a few minutes in the peritoneal cavity. In less than five minutes from the time it has been poured into the cavity, all excess alcohol is removed by siphonage.

We regard free drainage as a corollary and an essential measure in the treatment of suppurative peritonitis. It is always employed through a widely open portal, and accessory drainage is provided, if necessary, through additional openings in the abdominal wall. One is usually made through the lateral abdominal wall into the kidney fossa. Gravity drainage has been found beneficial. In some instances we have placed the patient in a ventral or right lateral position in order to facilitate dependent drainage.

During the course of our work, we have made the following observations:

1. Cultures taken from the fluid exuding from the incision when the abdominal cavity was opened in some cases was found to be free of organisms. In the same patient a culture taken from the wound discharge one or two days later usually showed *B. coli*. Negative cultures we think may be due to the fact that the specimen is taken from the supernatant fluid which extends beyond the active margin of the peritonitis and, as a rule, is sterile.

2. Drainage in every instance was thought to be beneficial. In cases where intra-abdominal alcohol lavage had been used, there was almost complete cessation of discharge from the drainage openings for the first few days. Following this restriction period there was a gradual return of drainage usually containing *B. coli* and of a foul odor.

3. If, on dressing the wound, we find the discharges from the wound infected with *B. coli*, it is our custom to instill pure cultures of lactic acid *B.* or acidophilus bacilli into the infected cavity. In a few days, the quantity of the discharge is greatly reduced, it becomes more fluid and acquires the sour odor of lactic acid. The colon bacilli when present rapidly disappear, but streptococci or the staphylococci, when present, apparently are not affected. These are subsequently destroyed by the local instillation of 70 per cent ethyl alcohol.

4. We have determined that alcohol can be absorbed from the peritoneal cavity. In

a few patients the absorption is so great that a mild degree of intoxication is induced. It is surprising to observe the happy and undisturbed state of mind of many alcohol lavaged patients, operated on under spinal anesthesia. This carefree attitude remained an enegma to us until chemical examination of the blood twenty minutes to three hours after alcohol lavage showed 10 to as high as 52 mg. of alcohol per 100 c.c. This amount was found after twenty minutes and, as a rule, decreased after two hours, increasing again at the three hour interval. We came to the conclusion that the primary increase was most probably due to a rapid immediate absorption of alcohol through the serosa of the peritoneum; the decrease which followed the primary increase we thought was due to an increased elimination which temporarily overbalanced the absorption of alcohol. The absorption during the second hour period, we thought, was slowed by a decreased peritoneal absorption due to the paralyzing effect of the alcohol on the vessels of the serosa, as well as to the precipitation of a fibrinous albuminous deposit on the surface of the serosa. As this fibrinous material was dissolved, increased absorption again occurred, with consequent increase in the alcohol content of the blood. This hypothetical explanation may not be correct, and in some instances the quantities of alcohol in the blood did not correspond to the above formulations.

5. Where alcohol was used the usual complications of suppurative peritonitis, such as gastromesenteric ileus, paralytic ileus, tympany, persistent vomiting and hiccoughing, seldom occurred.

6. The beneficial effect of alcohol, we believe, is the result of the following factors:

(a) Its action as a bactericide on the infecting causative organism or organisms. This was particularly noted in peritonitis due to B. coli and streptococci.

(b) Reduction of the activity of bacterial organisms which survived the initial contact with the lavaging alcohol. There was a minimum of discharge from the wound or none at all for a few days after operation, a period which may coincide with that required for a new and more resistant generation of bacterial organisms to develop.

(c) Increase of resistance in this latent period, of all the tissues, and particularly those in the localized areas of infection, against the offending bacteria, to such a degree that in the contest of opposing forces the bacteria are destroyed.

(d) During this interval of latent activity, it may be assumed that there is decreased absorption of toxins and poisonous tissue products from the infected areas in the abdominal cavity. The alcohol has coagulated the albuminous content of the exudate which is spread as a nonpermeable fibrinous layer on the surface of the peritoneum.

(e) At the same time a hyperemia is induced in the surface layers of the peritoneum, constituting an added protection to the underlying tissues. In some instances, the hyperemic reaction of the peritoneum is so great that small petechial hemorrhages are seen under the serosal layer.

(f) It has been suggested that inhibition of absorption of toxic products from the abdominal cavity may be the result of an exosmosis which the alcohol may cause. The restriction of immediate postoperative absorption from the abdominal cavity is indicated by the increased absorption of alcohol in the third hour after intra-abdominal instillation. The beneficial systemic effect of the counter action of toxic products in the circulation, is indicated by a rapid reduction in the pulse rate and drop in temperature.

(g) The variable amount of alcohol absorbed into the blood in different individuals may act as a mild blood antiseptic and be a source of energy for the destruction of foreign proteins and other toxic substances. With this object in view we have advocated, and have used with satisfying results, the intravenous introduction of alcohol in the treatment of severe hemolytic streptococcus septicemia. In some

cases the intravenous injection of alcohol in proper dilution (25 per cent in salt solution) has been used as a supportive measure in acute suppurative peritonitis.

(h) In extremely weak patients, alcohol, injected intravenously properly diluted with saline solution, not only has antiseptic value, but may also be of nutrient value because of its high caloric content. In fact, because of the ease by which it is oxidized, alcohol may be more advantageous than glucose.

In reviewing hospital records for mortality statistics in generalized diffuse peritonitis following appendicitis, certain diagnostic criteria must be observed. It is important that the diagnosis be correct. We based the diagnosis of acute spreading peritonitis principally upon local symptoms and the general symptoms of peritonitis as usually defined.

In one case the sudden acute pain in the right side or umbilical region was followed by vomiting, which gradually subsided, the pain veering from the center of the abdomen to the lower right quadrant. The leucocyte and polymorphonuclear counts were high. The pain became worse and suddenly increased markedly. Vomiting recurred and shortly after this secondary exacerbation the abdomen was found very tense with release pressure tenderness marked. The leucocyte count was very high, the polymorphonuclear count usually increased and the patient appeared to be very sick. The pulse was rapid and soon became thready. The vomitus gradually changed until it finally consisted of a foul material of bad odor. Deep pressure tenderness on the abdominal wall caused the patient to assume a characteristic defensive position. He put his hand lightly on the abdomen and held the other raised to ward off any possible contact with the abdomen. This sudden defense reaction is instantly brought into play if a motion is made to touch the abdominal wall.

We regarded the diagnosis of acute diffuse peritonitis as confirmed if, when the abdomen was opened, there was free turbid fluid in the abdominal cavity, with positive bacterial flora. The omentum was usually tucked high up in the abdomen or was free without any definite limiting adhesive attachment. In other words, no attempt or very slight attempt had been made by the omentum to wall off the extension of the inflammatory process in the appendiceal area. In a few cases where an appendiceal abscess had been present and had suddenly perforated into the peritoneal cavity, a very fulminating type of peritonitis was found.

The results obtained by the use of alcohol have been computed by one of us (Wm. R.) from the records of all patients suffering from localized peritonitis and generalized peritonitis resulting from appendicitis in St. Joseph's Hospital. Forty-three cases of localized and forty-nine cases of generalized suppurative peritonitis (total ninety-two) were studied. Forty-six cases were treated by 70 per cent alcoholic lavage of the abdominal cavity; the remaining forty-six cases (handled by other members of the surgical staff) were treated in the usual manner by wide incision of the abdominal wall and removal, if possible, of the diseased appendix. If this was not regarded as advantageous, the appendix was allowed to remain and was removed at a later operation. The postoperative treatment in these cases was not markedly different from that used in the alcohol lavaged cases, except that in our personally treated cases we carried out frequent blood transfusions, gave large quantities of glucose intravenously, and make generous use of vascular stimulants and shock preventatives.

Acute suppurative appendicitis, localized appendiceal abscess, and generalized suppurative peritonitis were more prevalent in the age period of 10 to 40 years. The maximum number occurred in the period between 10 and 30 years. This definitely establishes, in our series, that serious appendicitis is a disease of youth and young adult life. The great number in this period may be due to neglect, since many, falied to see a physician early. This neglect appar-

ently was the result of economic stringency and the necessity of carrying on their daily work to earn a living. Appendicitis has more complications and seems to be more severe and fatal in the young adult.

TABLE I

Generalized Diffuse Peritonitis	Number of Cases	Deaths		Causes of Death
		No.	Per Cent	
1920–1933	46	2	4.3	1. Was moribund on entrance 2. A generalized peritonitis was induced postoperatively by ill advised and too forcible removal of gauze packs
1931–1939	23	2	8.7	1. Pneumonia (autopsy) 2. Postoperative shock (moribund)

	Alcohol Treated	Non-alcohol Treated
Time in hospital....	22.04 days	27.59 days
Highest postoperative pulse rate....	112	127
Time elapsed before normal temperature.....	9.1 days (1933–1939) 9.5 days (1920–1933)	12.48 days (1933–1939) 13.35 days (1920–1933)
Mortality.....	23 cases (1933–1939) 2 deaths (8.69 per cent) 46 cases (1920–1933) 2 deaths (4.3 per cent) Total—69 cases 4 deaths (5.79 per cent)	26 cases (1933–1939) 12 deaths (45.39 per cent) 44 cases (1920–1933) 22 deaths (50 cent)

Males were more frequently affected than females in the ratio of 59 to 33.

Of the ninety-two cases of peritonitis (localized and general) forty-three, or 47 per cent, had localized peritonitis and forty-nine, or 53 per cent, had generalized peritonitis.

The average delay in this series of cases was one to twenty-two days, with the average time of operation about 4.23 days (101.52 hours) after the onset of the acute symptoms. The average period of delay before operation, in patients in whom alcohol lavage was used was 4.77 days (112.8 hours); in the patients in whom alcohol was not used, the average period between the onset of symptoms and operation was 3.69 days (93.6 hours).

Patients treated with intra-abdominal alcohol lavage recovered more quickly than did those in whom alcohol was not used. In the alcohol treated group the temperature dropped to normal an average of 9.1 days after operation, with the shortest period three days and the longest forty days (the latter in a case complicated by postoperative intestinal obstruction). The average of 9.1 days may be compared with an average of 12.48 days in cases not treated by alcohol. The shortest time in which the temperature returned to normal in this series of cases was three days, the longest time was fifty-nine days. The average difference was 3.38 days. This is an important factor, since the earlier drop in temperature enhances the comfort and well-being of the patient, permits earlier recovery and more prompt discharge from the hospital. The pulse rate rose postoperatively, in the alcohol treated cases, to an average of 112; it was 127 in the other series. This may indicate that patients treated with alcohol did not remain so toxic. The pulse rate was obviously not measurably accelerated by the use of alcohol.

The average time of hospitalization was markedly less in the patients who were treated with alcohol, 22.04 days on the average, as compared to 27.59 days for those treated without alcohol, a difference of 5.5 days. The average length of hospitalization in the combined series of cases was 23.83 days.

Abdominal cultures were taken in sixty-nine of the ninety-two cases (75 per cent). Single organism cultures were positive in fifty-four, or 75 per cent. Thirty-two of the

fifty-four positives were from Dr. Behan's service; twenty-two were pure cultures of a single type of organism, twenty-one Gram-negative bacilli and one Gram-positive diplococci. Of the remaining twenty-two positive cultures, eleven were single organism cultures, ten pure Gram-negative bacilli and one a staphylococcus. Of the thirty-three single organism cultures, 61 per cent of the total positive cultures, thirty-one (57 per cent) were pure cultures of Gram-negative bacilli. Twenty-one of the remaining positive cultures contained two or more of the following organisms: streptococcus, staphylococcus, Gram-positive and negative bacilli, Gram-positive diplocci.

In the last series of forty-nine cases of generalized peritonitis in St. Joseph's Hospital, twenty-three were treated with intra-abdominal alcohol lavage. Two deaths occurred, a mortality rate of 8.69 per cent. One of these deaths occurred on the seventh day postoperatively and was due to pneumonia. Autopsy showed a typical left lower lobe lobular pneumonia (type 2). The abdomen was free of fluid, and only a small quantity of fibrin was present in the area from which the appendix had been removed. The second death was that of a small boy who had been sick for five days before entering the hospital. At the time of entrance, the abdomen was enormously distended. After removal of the appendix it was very difficult to reintroduce the intestine into the abdominal cavity. This was accomplished only after intestinal aspiration and the introduction of a catheter into the lumen of the bowel. We feel that this case was not properly treated and that the trauma and injury to the intestines caused the shock which, in spite of all our efforts, terminated the child's life twelve hours later.

In this period from 1920 to 1931 we had forty-two cases of generalized suppurative peritonitis resulting from appendicitis in which treatment with alcohol was given. Only two deaths occurred in this series, making four fatalities in sixty-five cases of generalized suppurative peritonitis or a *mortality of 6.15 per cent* since 1920. Of twenty-six similar cases in the same hospital not treated with alcohol, twelve died, a mortality rate of 45.39 per cent.

Reed and associates reported a rate of 33.9 per cent in this type of case; Hawk and Woodhouse had a 60 per cent mortality. King reports eighteen deaths (15.5 per cent) in 116 cases of all types of peritonitis complicating appendicitis and 52.9 per cent in diffuse spreading peritonitis. Ruddel, Sicks and Loomis had a mortality in diffuse peritonitis of 30 per cent. LeGrand Guerry treated 123 cases of spreading peritonitis by deferred operation, with two deaths, a mortality of 1.6 per cent. At the same time eighty-five cases of diffuse peritonitis in immediate operation was done showed seven deaths, or a mortality of 8.2 per cent. In 1932, ninety-three cases of diffuse peritonitis were operated on immediately, with ten deaths, a 10.7 per cent mortality, while 128 cases of diffuse peritonitis treated by deferred operation showed two deaths, or a mortality of 1.5 per cent. Hamilton Bailey also reported a very low mortality (1.6 per cent) in the deferred operation cases. Sworn and Fitzgibbon (1939) from the St. Thomas Hospital, London, report a 19 per cent mortality in 231 cases of ruptured appendicitis with peritonitis. Reed and his associates (1936) had 33.9 per cent mortality in ruptured appendicitis with generalized peritonitis. We had no fatalities in perforated appendicitis with localized peritonitis, as compared to a 6.30 per cent mortality reported by Hawk and Woodhouse.

We found that the death rate was higher in males than in the females. This is in accordance with the frequency of the occurrence of the disease; although acute suppurative appendicitis was found to be more frequent in females.

Patients in the decade between 20 and 30 years of age suffered the smallest number of deaths. The greatest proportional mortality occurred in the 50–60 year period; this, according to our statistics, was found to be the most dangerous decade of

all, with the exception of the extreme old age groups.

CONCLUSIONS

1. Acute appendicitis is definitely a disease of the young, especially those in the third and fourth decades.

2. Males are more frequently affected by serious acute appendicitis than are females.

3. There usually is a dangerous delay, which in our series averaged about 101 hours, from the time of the onset of the symptoms of acute appendicitis until operation.

4. In 33 per cent of the general peritonitis cases laxatives had been given prior to operation. These were the most serious cases. Bowers found that a laxative given to patients with appendicitis complicated by peritonitis reduced the chances of recovery to one in seven.

5. In suppurative peritoneal involvement, the abdominal cavity is lavaged with 70 per cent alcohol at the time of operation, and the temperature falls to normal in about 9.1 days as compared to 12.48 days when alcohol is not used.

6. Alcohol lavage has no noticeable effect upon the pulse rate.

7. The use of alcohol lavage cuts down the length of hospitalization markedly (5.5 days).

8. The death rate in the series of generalized peritonitis treated with alcohol was 8.69 as compared to 45.39 per cent in the cases not treated with alcohol. We had no deaths in our cases of localized peritonitis. The deaths in the generalized peritonitis were not due to the peritonitis but to complications.

9. The prognosis is much better in patients in whom the culture from the intra-abdominal exudate shows a pure strain of organism than it is in those in whom such culture shows the presence of more than one organism.

10. The mortality rate was higher among males than among females.

11. The lowest group mortality occurred in the age group 20 to 30 years and the greatest in the sixth decade.

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CASE REPORTS

SUBACUTE OBSTRUCTION OF THE RECTOSIGMOID BY ADHESIONS*

A METHOD OF PREVENTING ITS RECURRENCE

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IT is so unusual to have obstruction of the rectosigmoid from peritoneal adhesions alone in an individual over 50, that one must in such obstruction act with a definite suspicion of malignancy. It is, however, unnecessary, once malignancy is definitely ruled out, for the patient to continue with a permanent colostomy if some method of straightening out the rectum can be devised. In the following case a procedure for accomplishing this and reëstablishing continuity of the bowel is described.

M. M., a single white woman of 58, was first admitted to the Mt. Vernon Hospital on December 30, 1935. She had had general abdominal cramps with distention for two weeks and intermittent vomiting during this period. She had always been constipated, but this constipation had been increasing in the preceding few weeks. She had lost 30 pounds and had been generally feeling poorly in the last year.

She was pale and undernourished, and her abdomen was considerably distended and tympanitic without masses or tenderness. Rectal examination showed an indefinite mass at the tip of the examining finger on the left. White blood count was 28,600 with 78 per cent polymorphonuclear leucocytes. Barium enema showed an almost complete obstruction near the rectosigmoid junction with what appeared to be a filling defect and narrowing of the bowel, but the barium passed on up into the colon through this obstructed area.

It was felt that the patient had a carcinoma of the rectosigmoid with subacute intestinal obstruction. She was given a transfusion, and on January 6, 1936, the abdomen was explored through a lower midline incision. The intestines, especially the colon down to the rectum, were markedly distended, and there was considerable free hemorrhagic fluid in the peritoneal cavity. Because of the distention it was impossible to explore the pelvis well, but it was felt that there was possibly a mass in the left pelvis. A loop colostomy was done through a left pararectus stab wound.

Following operation there was a fairly smooth course, and the colostomy functioned well. Irrigations of the lower segment were attempted, but it was found that while it was possible to irrigate the rectum from below upward, this could not be done from above downward. Proctoscopy was done, and an obstruction of the rectum at 6 inches was found, but there was no tumor visible.

On February 26, 1936, a second operation was done and no tumor was found, but it was discovered that the rectosigmoid was bound down in the pouch of Douglas so that the rectum and sigmoid made a complete S, with the upper loop directly over the lower. It was felt at this time that this was the cause of the obstruction through a ball-valve action. The adhesions were freed, a Mikulicz clamp applied to the colostomy spur, and a biopsy of the perirectal tissue taken. This showed a nonspecific granuloma.

The patient's postoperative course was quite smooth, but no fluid could be passed from above the rectum downward. Another proctoscopic examination showed the same condition

* From the Surgical Service of the Mt. Vernon Hospital. Read before the Section on Surgery, New York Academy of Medicine, January 6, 1939.

as the first. The patient was discharged home in good general condition with a well-functioning colostomy.

FIG. 1. December 31, 1935. Previous to first operation. Barium enema. Partial obstruction to the flow of barium at the junction of the rectum and sigmoid with the suggestion of a tumor in this location.

The patient knew that she did not have a cancer, and since her colostomy was troublesome, she was anxious to have it closed, if possible. Proctoscopy was done both through the rectum and through the colostomy, and in both cases the proctoscope came up against rectal wall as it looped upon itself. During a period of a month or so several fecal impactions occurred in the rectum and had to be removed digitally, causing considerable distress. This, of course, proved that there was some fecal material getting through the obstructed area. Barium *x*-rays of the rectosigmoid segment were taken with the barium passed through the colostomy. There was delay, but without definite obstruction in the lower sigmoid and a complete obstruction just above the rectal ampulla and to the left of the midline, beyond which the barium could not be forced. This point of obstruction could be felt through the rectal wall at the tip of the finger. The barium was removed, and then barium was introduced through the rectum and found to flow without delay through the obstruction up the sigmoid and out the colostomy. These findings confirmed the idea of an S-shaped loop of lower sigmoid and upper rectum adherent in the pelvis with a ball-valve type of obstruction.

Operation was done on July 23, 1936, through another lower midline incision. The condition was verified. The lower sigmoid and upper rectum were firmly bound down in this S-shaped manner to the posterior aspect of both tubes and ovaries and the uterus. As far as could be made out these organs were normal. The adhesions did not give the impression of being the result of a previous salpingitis with pelvic peritonitis, although this was possibly the etiology. There were no diverticula in the sigmoid, and there was no tumor. The adhesions were separated and the peritoneum in

FIG. 2. July 16, 1936. Previous to third operation. Barium through tube in colostomy. There is a tube in the rectum also. Apparently complete obstruction in the rectum to the downward flow of barium.

FIG. 3. July 21, 1936. Previous to third operation. Barium enema. There is delay to the flow of barium in the upper rectum. The barium did, however, slowly flow into the sigmoid and out through the colostomy.

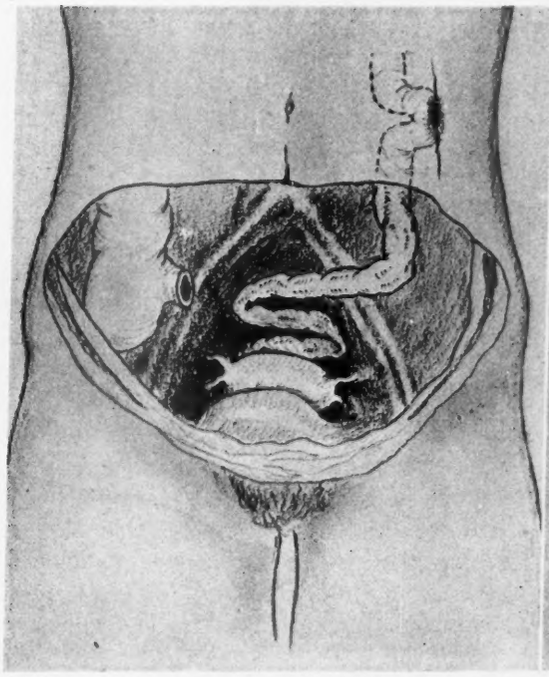

FIG. 4. Diagram of pathology found at third operation. There is an S-shaped loop of rectosigmoid bound down in the cul-de-sac by adhesions. This caused a ball-valve type of obstruction with almost complete interference to passage from above downward but only moderate from below upward.

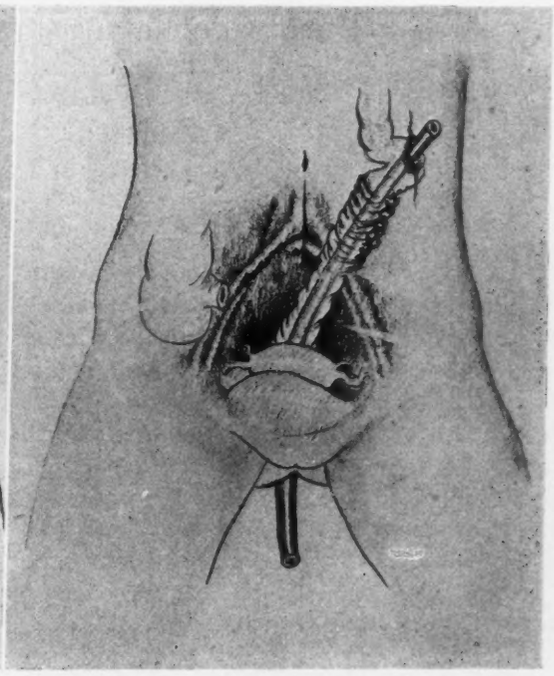

FIG. 5. Diagram of procedure at third operation. The adhesions have been broken up and the rectosigmoid straightened out. A large rubber tube has been inserted from the rectum upward and out the colostomy, and the sigmoid has been pleated up into the left lower quadrant with sutures.

the depth of the cul-de-sac opened. A hand was then placed down into the hollow of the sacrum as far as the coccyx, and by thorough dissection it was possible to straighten out the sigmoid and rectum completely. Several attempts were made by an assistant to pass a half-inch rubber tube through the colostomy down into the rectum and several more to pass it from the rectum up. A final attempt through the rectum was successful, and the two ends of the tube were brought out through the colostomy and rectum respectively. The sigmoid was then pleated up along the tube and the pleated portion sutured to the lateral peritoneum in the left lower abdominal quadrant. Two large rubber dam drains were placed down alongside the rectum on each side of it and brought out in the lower angle of the wound. With the abdomen still open a Mikulicz clamp was applied by an assistant to the colostomy spur and guided from inside the abdomen, since no true spur had been constructed.

The patient had a smooth, uneventful convalescence. The hard rubber tube was removed on the seventh postoperative day. Following its removal it was found that it was easily possible to pass water through the rectal segment from above downward as well as from below upward. There was practically no drainage from the wound, and the drains were removed on the eighth day. The patient was discharged in good general condition.

Fig. 6. Barium enema two years after last operation (closure of colostomy). There is no obstruction, and except for a somewhat redundant loop of rectosigmoid the bowel is quite straight. A small remaining spur at the site of the closed colostomy is evident.

It was found that the spur had not been well cut down, and, consequently, Ochsner clamps were applied to it on two successive occasions, August 16 and October 11, under evipal anesthesia. Each time that these clamps were applied the patient had a great deal of pain with vomiting and distention for a day or so, but her subsequent course showed no evidence of injury to any other loop of intestine. The considerable time that was left between applications of clamps was necessary because of the marked edema of the spur which devel-

oped each time. During this time catheters were readily passed through the rectosigmoid segment from above and below, and it was kept well open, although the patient's bowels did not move by rectum even after the last time that the clamps were applied.

On December 3, 1936, an extraperitoneal subfascial closure of the colostomy was done after applying two large Ochsner clamps to the depth of the spur in V fashion, cutting out the intervening tissue with the actual cautery, and then removing the clamps.

Following operation the patient became markedly distended and had abdominal cramps with nausea and vomiting. On the night of the third postoperative day she suddenly passed a large amount of gas by rectum and was immediately relieved. Cramps and distention bothered her slightly until the seventh day, but from then on her bowels moved normally by rectum with mineral oil and milk of magnesia. Moderate infection developed in the wound, and there was slight fecal drainage for a few days only. She was discharged from the hospital on the seventeenth postoperative day with her abdominal wound practically healed.

In the two years since the last operation, the patient remained perfectly well. She gained 35 pounds in weight, and her bowels moved normally by rectum with the help of small amounts of mineral oil and milk of magnesia. All the abdominal wounds healed well and in spite of some weakness in the thrice-opened lower midline incision, there is no actual hernia.

THERE may be some tenderness along the veins in acute or subacute phlebitis. One may find more or less tenderness along the arteries in periarteritis nodosa.
From—"Peripheral Vascular Diseases" by Kramer (Blakiston).

VOLVULUS OF THE STOMACH

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MILWAUKEE, WISCONSIN

VOLVULUS is a rather unusual type of displacement of the stomach wall. Congenital anomalies of the stomach are rare, hypertrophic pyloric stenosis in infancy being the most frequent abnormality. Diaphragmatic hernia ranges next in occurrence. Partial or complete situs inversus seldom gives rise to complaints. The stomach may be incarcerated in an abdominal hernia, or more often, a small portion may be occluded within an epigastric hernia, causing great pain. Intussusception following gastroenterostomy and consisting of telescoping of the jejunal stoma into the stomach has also been reported. Recently phrenicotomies have been thought to lead to displacement and functional derangement of the upper portion of the stomach, a view promulgated especially by French authors. A lengthening of the mesentery seems to be the causative agent in such cases.

Volvulus is a twist of an organ around an axis. It represents a rotation brought on chiefly by extrinsic factors. Congenital elongation of the ligamentary apparatus of the stomach is essential in producing this type of displacement. Another prerequisite appears to be a short based pedicle around which rotation may take place. Various factors which favor such twisting and rotating movements include a change of intraluminal pressure.[9] Any increase of the latter accentuates motility, and in stomachs with a sufficient amplitude of peristaltic play, it may cause angulation and kinking. Such torsion may finally culminate in an actual twisting of the whole viscus.[7]

Cases of volvulus of the stomach are quite rare, about seventy-five having been reported in all.

The picture in acute volvulus consists of marked distention, vomiting, peripheral collapse, and other signs of high intestinal obstruction. The diagnosis is often difficult, and may be confused with ruptured viscus, acute pancreatitis, a cardiac catastrophe, or mesenteric thrombosis.[2,7,14] Preceding gastric symptoms are lacking, although ptosis is usually present. Many authors believe that a concommitant lesion, especially ulcer of the stomach, is the factor responsible. An example of this is the hour-glass stomach, when the distal portion "gives away" and undergoes a complete rotation. More often, however, adhesions to the pancreas or penetrations into the adjoining organs may furnish the anchorage around which the rotation takes place.[3,6,9,11]

The volvulus may be total or partial. Total volvulus represents a rotation around an axis of 180 degrees, so that the greater curvature is approximated to the diaphragm, and the posterior wall is facing the anterior abdominal wall. The twisting takes place usually from right to left around a vertical axis. (Figs. 1 and 2.) A rolling from the anterior to the posterior aspects occurs around a transverse axis, a less frequent type of rotation. (Figs. 3 and 4.) The adjoining organs, especially the spleen and the transverse colon, are frequently involved.

A traction on the esophagus may obliterate the cardiac orifice, and no stomach tube can be passed. Due to the kinking of the lesser curvature, two isolated sacs, the cardiac and the pyloric portions of the stomach are found. The right colon may become displaced because of a twisting and shortening of its mesentery. A contracted mesocolon produces a derangement in the colonic passage in the right half. This may render reduction very hazardous at times.[9]

Acute volvulus is a surgical problem. The onset is sudden, with pains, vomiting, inability to swallow and marked distention,

with peripheral collapse. Unless surgery is instituted, the outcome is always fatal. In partial volvulus the findings are less characteristic. Long-standing digestive disturbances, vague in character, may obscure the underlying pathology. Usually, there is ptosis, with accompanying laxity of the mesenteric attachment. Other gastric lesions may be found, including gastric ulcers with penetration, hour-glass contraction, and severe perigastritis. Internal herniae, due especially to congenital slits in the mesocolon, and duodenum mobile range next in frequency. The exciting cause is the vigorous peristalsis most commonly produced by overfilling of the stomach.

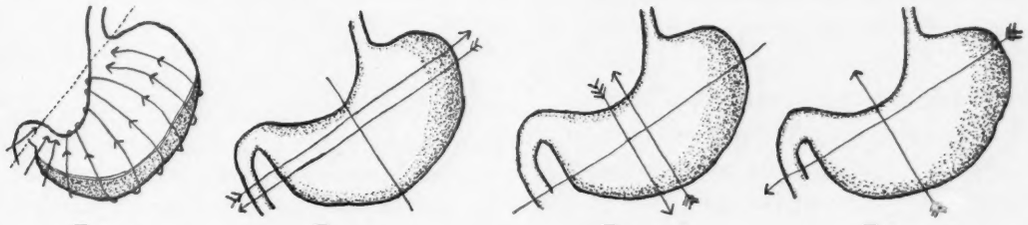

FIG. 1. FIG. 2. FIG. 3. FIG. 4.

FIG. 1. Axis of rotation of lesser curvature in volvulus of the stomach. (After Thorek.)
FIG. 2. Rotation around the transverse axis. (After Kocher.)
FIG. 3. Rotation around the longitudinal axis. (After Kocher.)
FIG. 4. Rotation around the transverse and long axis as in case reported.

FIG. 5. *X*-ray shows a "tipped over" stomach. Cardia at the level of the pylorus. Large penetrating ulcer, U, on the lesser curvature. The greater curvature is situated above the lesser curvature, and is approximated to the anterior abdominal wall.

Diagnosis is difficult, and only *x*-ray examination enables one to evaluate the confusing pathology. Treatment in the acute total volvulus presenting high intestinal obstruction is surgical, consisting of reduction of the volvulus and gastropexy in order to prevent recurrences. The reduction is not complete until the coronary vessels are in their normal anatomic relation. Mortality is about 60 per cent. In the partial, intermittent type of volvulus, medical management often suffices if no coexistent lesion is noted. Whenever intrinsic gastric pathology complicates the picture, gastroenterostomy is necessary.

CASE REPORT

A. F., 70 year old female, reported in September, 1938, stomach complaints of ten years' duration. Pains had occurred two hours following meals and at night and were relieved by food and alkali. *X*-ray examination in 1928 disclosed ulceration of the stomach that responded well to medical management. A few years later, she suffered recurrences and periodical exacerbations. She did not lose any appreciable amount of weight, but had stabbing pains in the epigastrium, associated with nausea.

Stomach analysis showed the presence of free HCl with hypoacid readings.

The *x*-ray examination was highly illuminating. *The cardia occupied the level of the pylorus.* The air chamber was also in this unusually low position. The lesser curvature was situated above the greater curvature, and the cardia had become approximated to the pylorus. At about the midportion of the lesser curvature, a smooth-walled crater the size of an English walnut was seen. (Fig. 5.) The outlines of the remaining portions of the stomach were normal. The colon, gall-bladder, etc., failed to reveal signs of organic pathology.

This observation, confusing at first, led one to believe that the stomach had rotated almost 180 degrees around its imaginary transverse axis.

A diagnosis of chronic volvulus of the stomach with penetrating ulcer on the lesser curvature was made. The patient received the customary medical management without relief. She suffered a great deal of pain, necessitating opiates, and, about six weeks later, vomited a copious amount of blood. Several transfusions were necessary to restore her blood volume. In view of the fact that a repeated hemorrhage was threatened, (poor quality of pulse, arteriosclerotic, friable blood vessels) and that her severe gastric pains persisted, laparotomy seemed advisable.

A rotated stomach with an exceptionally long mesenteric attachment was found. The cardia occupied the level of the pylorus, pulling the distal portion of the esophagus downward. There was a penetrating ulcer at about the midportion of the lesser curvature with dense adhesions to the pancreas. It evidently served as the fulcrum around which the stomach performed its unusual excursion and rotation. Because of the contracted and shortened mesocolon, an anterior antecolic short-circuiting gastroenteroanastomosis was done. The postoperative course was uneventful, and the patient has been relieved of practically all her digestive complaints.

SUMMARY

Chronic volvulus of the stomach is of rare occurrence. Factors inducing this lesion are chiefly, visceroptosis, abnormally long mesenteric attachment, and other congenital malformations of the suspensory apparatus. The acute type of chronic volvulus needs immediate surgical interference consisting of a reduction and pexy. The chronic type is often intermittent, reversible, and at times, may be approached medically. However, if a concomitant lesion is found responsible, surgery is necessary.

A case of chronic volvulus of the stomach is presented. A huge penetrating ulcer on the lesser curvature with subsequent complications necessitated surgical interference. An anterior antecolic gastroenterostomy was successfully performed.

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The symptoms of duodenitis (or "ulcer duodenitis") are very similar to those of duodenal ulcer; and many patients suffering from it are operated on in the belief that they are suffering from duodenal ulcer. However, on the basis of this "ulcer duodenitis" a definite duodenal ulcer may subsequently develop.
From—"Surgery of the Alimentary Tract" by Devine (Williams & Wilkins).

DIVERTICULITIS OF THE CECUM

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MULTIPLE diverticulitis of the left side of the large bowel is a more or less common condition. According to a report published by W. J. Mayo[1] in 1930, it occurred in 5.7 per cent of 31,838 colon examinations carried out in the Mayo Clinic from 1924 to 1930. Thirty per cent of these cases had the disease in its recognized clinical form.

Diverticulitis of the right side of the large bowel is a rare disease, and most unusual when confined to the cecum alone. Cases of solitary diverticulitis of the cecum have been reported, but a survey of the literature by Bennett-Jones[2] in 1937 revealed only seventeen such cases. He reports three new cases.

Nowhere in the available literature was there an account of diverticulitis of the cecum associated with diverticulosis of the right half of the colon, so the occurrence of five such cases at The Clinic in the past ten years was felt of such interest as to justify reporting. Three of these cases were seen in the last year.

There are two types of diverticula, the true and the false. True diverticula are abnormal pouches that have their walls made up of the same structures as the organ involved. This type is best illustrated by Meckel's diverticulum. Most diverticula of the large bowel are of the false variety—that is, one or more layers of the normal bowel wall are absent. Many authorities claim that only the Meckel's diverticulum is a true congenital diverticulum, while all others are false or acquired. Leonardo,[3] however, in 1930 reported a solitary diverticulum of the cecum that had circular muscle fibers present in part of its wall. With reference to the large bowel alone and to the cecum in particular, we may safely state that the great majority of the diverticula present are of the false or acquired variety. These are further divided into the primary and secondary types. The primary type is thought to be very rare, as pointed out by Bennett-Jones. The secondary types are also unusual, but as noted by Greensfelder and Hiller,[4] may not be so rare as previously supposed.

The etiology of these secondary diverticula is well known. They arise as a result of some operative procedure in the right lower quadrant. The etiology of the primary type is still quite obscure. The epiploic appendages, the piercing of the bowel wall by blood vessels, loss of fat and changes in intra-abdominal tension may play a part, but, as pointed out by Greensfelder and Hiller, do not satisfactorily explain all cases. They offer another possible etiologic factor, the retention of some residual form of the appendix. Leonardo's case would tend to support this theory. The fact remains that the diverticula are simply outpouchings or herniations in the wall of the bowel, and their presence is due to the failure of that portion of the wall to retain its normal contour.

The diagnosis of diverticulitis of the cecum is usually made at the time of operation. Except for a slightly milder and more prolonged course in the case of diverticulitis it cannot be differentiated from appendicitis. There is less tendency towards vomiting, but the laboratory and physical findings are the same. As pointed out by Cooke[5] it is just another of the conditions with which a surgeon must be able to cope after he has made the diagnosis of appendicitis.

The treatment of diverticulitis of the cecum varies according to the condition found at operation. Several of the cases reported have required resection of the diverticulum. Others were so extensive as to

require resection of the cecum. In several of the articles published, Stewart's[6] in particular, attention was brought to the low mortality rate—all cases having recovered. When the associated high mortality of surgery of the large bowel is considered, and several of the cases required resection, perhaps the favorable outcome was due to the skill of the surgeon rather than to the benignity of the lesion. There is, however, a wealth of evidence to prove that an inflammatory diverticulum per se is not a dangerous condition. Their course as a rule is to subside without perforation or other complications. Bennett-Jones is of the opinion that failure to recognize the condition leads to more radical surgical procedures than the disease requires.

No case in this series required extensive surgical procedures. In one case the diagnosis was tentatively made without exploration. The appendix had been previously removed. After the acute stages were over the diagnosis was confirmed by a colon enema. In two cases the findings were such that it was impossible to differentiate periappendicitis from true appendicitis. In the other two cases the appendix appeared normal. The appendix was removed in all instances.

CASE REPORTS

CASE I. Mrs. F. G., white, age 30, was first seen on November 2, 1928 complaining of pain in the right lower quadrant, associated with nausea and vomiting for the previous twelve hours. The temperature was 99.2°F., white cells 9,000, polys. 82 per cent. The urine was negative. There was localized tenderness with marked rigidity over McBurney's point. Pelvic examination was negative. A diagnosis of acute appendicitis was made, and an immediate operation performed.

Through a low right rectus incision the appendix was inspected and looked normal. There was an intense inflammatory reaction about a cecal epiploica opposite the appendix. When this was opened a gangrenous diverticulum was seen. It was removed and the hole in the cecum repaired. The appendix was removed. Convalescence was uneventful.

A barium colon study ten years later revealed two diverticula on the medial wall of the cecum, and one at the hepatic flexure of the colon.

CASE II. Mrs. K. I., Japanese, age 60, was seen on September 12, 1935 complaining of pain in the mid-lower abdomen for twenty-four hours; the pain had finally shifted to the right lower quadrant. Slight nausea was present. Temperature was 99°F. There was exquisite tenderness in the McBurney area with rigidity. Pelvic examination was negative. No history of previous similar attacks was elicited. White cells numbered 11,000, polys. 72 per cent. There was no history of urinary disturbance, although the urine examination revealed 2 plus albumin with an occasional cast and red cell. The diagnosis of acute appendicitis was made.

Through a low right rectus incision the appendix was explored. It appeared grossly negative. Opposite the appendix on the lateral border of the cecum was an inflammatory mass the size of a hen's egg. One small diverticulum was seen, and with gentle dissection of the inflammatory mass another appeared, acutely inflamed and containing a fecal concretion. This diverticulum was removed and the opening into the cecum repaired. The appendix was removed and two rubber tissue drains inserted through a stab wound in the McBurney area. Convalescence was very stormy. Two weeks after the primary operation a second operation for intestinal obstruction was necessary. This revealed obstruction at the ileocecal junction as a result of inflammatory reaction. An enterostomy with 24 F. catheter was made. Following this the patient slowly recovered, aided by several transfusions, and was discharged on November 21, 1935, seven weeks later.

After the second operation there was considerable wound infection and a fecal fistula formed. However, this healed during the eighth week of illness. She has had no symptoms referable to the abdomen except a dragging sensation due to an incisional hernia that was relieved by an elastic girdle. No barium study of the colon has been made.

CASE III. Mr. C. C., Chinese, age 22, was first seen on January 29, 1938 complaining of pain in the right lower quadrant for the previous thirty-six hours, with anorexia but no vomiting. There was no history of previous similar attacks. The temperature was 101°F.,

white cells 18,000, polys. 78 per cent, with a slight shift to the left. The urine was negative. Physical examination revealed exquisite tenderness over McBurney's point with the suggestion of a mass. A diagnosis of acute appendicitis was made.

A McBurney incision revealed an acutely inflamed appendix. Opposite the appendix on the lateral wall of the cecum was an indurated inflammatory mass, the size of a lemon, with a soft spot in the center. Palpating through the opposite wall of the cecum it was felt that this soft spot was a hole in the lateral wall of the cecum. It was believed that adequate evacuation of the diverticulum had occurred into the lumen of the bowel and further exploration was unsafe. The appendix was to gross appearances acutely inflamed and was therefore removed. Two rubber tissue drains were placed lateral to the cecum and brought out through the wound. Convalescence was uneventful. The drains were gradually removed. A barium enema three weeks later revealed a diverticulum of the medial wall of the cecum, but none was seen at the site of the inflammatory mass or in any other portion of the colon. The tissue report on the appendix removed was "negative except for marked periappendicitis."

Case iv. Mr. S. N., Japanese, age 38, was seen on July 17, 1938 complaining of pain in the right lower quadrant for forty-eight hours, with, however, no nausea, vomiting, or distention. His temperature was 99.2°F., white cells 12,800, polys. 80 per cent. The urine was negative. There was exquisite tenderness over an old McBurney scar. The appendix had been removed eight years previously, the history at that time having been typical of acute appendicitis. The surgeon who had removed the appendix was a capable one. We felt that we were dealing with a diverticulitis and the patient was admitted to The Queen's Hospital and given expectant treatment. A series of blood counts and his clinical course showed the infectious process to be improving.

A barium enema on the second hospital day revealed a small diverticulum on the medial wall of the cecum. No others could be seen in the rest of the large bowel. The patient was discharged symptom-free after five days' observation. No positive physical findings remained.

Case v. Mrs. S. M., Portuguese, age 42, was first seen on January 5, 1939. She had had pain in the epigastrium for thirty-six hours, and it had gradually shifted to the right lower quadrant. Nausea and vomiting had been present for nine hours, and the pain had become very severe in the last four hours. Her temperature was 100.6°F., white cells 13,500, polys. 85 per cent. The urine was negative. The abdomen was extremely tender just above and to the right of McBurney's point with marked rigidity. A diagnosis of acute appendicitis was made.

Through a lower right rectus incision the appendix was located. It was thick, indurated, but not acutely inflamed. There were two small diverticula on the medial side of the cecum. On the lateral wall of the cecum, opposite the appendix, there was an indurated inflammatory mass the size of a lemon. No areas of softness or localized masses were palpable. The appendix presented easily and was removed. Two rubber tissue drains were placed lateral to the cecum, adjacent to the mass, and brought out through a generous stab wound in the McBurney area.

The pathologic report on the appendix did not show any primary acute inflammatory process. Convalescence was uneventful.

X-ray study revealed the diverticulum seen at operation and also one at the hepatic flexure.

DISCUSSION

The history, clinical course and treatment of five cases of diverticulitis of the cecum have been briefly presented. The inflammatory process in each was not extensive. The operative procedures were conservative. Perhaps just criticism can be made as to relying on drains to take care of possible rupture through the serosa of the bowel. However, it was felt in two of the instances to be less dangerous than searching for and tying off the diverticulum itself. In all five cases other diverticula were seen at operation or their presence was discovered later. In two cases other diverticula than the one inflamed were recognized at the time of operation. In one the presence of multiple lesions was proved only at later *x*-ray examination. In none of the previously reported cases is there a report as to whether this search was carried out. It is only logical to assume that any patient

having a diverticulum in any portion of the colon might have more. Certainly the search should be made to rule out the multiplicity of lesions. In one case (Case 11) there was no follow-up barium enema. In four cases the pre-operative diagnosis of appendicitis was made, and the fifth case was typical of appendicitis.

SUMMARY

The study of these five cases and the review of the available literature give insufficient data to form definite conclusions, but certain salient features are emphasized.

1. Diverticulitis of the cecum clinically cannot be differentiated from appendicitis and must be considered when dealing with any pathologic process about the cecum.

2. The etiology is still obscure.

3. The treatment must vary according to the condition encountered, but it should be remembered that the tendency of diverticulitis is to subside spontaneously.

4. The disease is probably not so rare as previously supposed.

5. It is suggested that cases of apparent solitary diverticulitis of the cecum may be accompanied by adjacent non-inflamed diverticula, and that a careful barium study be made to rule out this condition.

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ADENOCARCINOMA OF THE JEJUNUM, TREATED BY ENTEROENTEROSTOMY AND COMPLICATED BY INTUSSUSCEPTION*

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W. C., a white male, aged 68, was admitted to the Cumberland Hospital on February 10, 1938, with a history of loss of 20 pounds in weight in the previous four months, and abdominal pain, vomiting and constipation increasing in severity and frequency in the previous ten days. The past and family history were irrelevant.

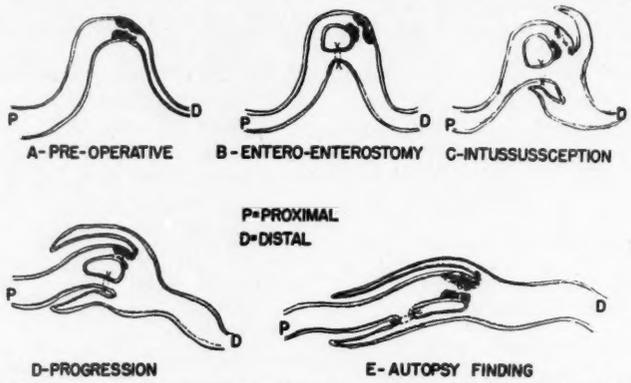

FIG. 1. Diagrammatic sketch indicating the probable pathogenesis for the intussusception. The shaded areas represent the neoplasm partly occluding the lumen of the jejunum. Note that the tumor and the entero-enterostomy suture line are in the inner loop of the intussusception in the diagram representing the findings at autopsy.

Examination showed cachexia. The temperature was 101.6, pulse 106, respirations 26, and blood pressure 118/64. Heart and lungs were negative. The abdomen was soft and distended. There was visible peristalsis in the right half of the abdomen. No masses were felt.

Blood study showed a moderate polynucleosis and an increased urea nitrogen content (34 mg.). Gastric analysis was normal. A flat plate of the abdomen showed distention of the intestine.

The patient was observed until February 11, 1938, when, under local anesthesia, an exploratory laparotomy was performed through a midline incision. A hard annular constriction of the jejunum producing intestinal obstruction was discovered. A diagnosis of carcinoma of the jejunum was made, and, because of the poor condition of the patient, resection was deferred and a side-to-side anastamosis short-circuiting the constricted portion was performed.

There was a marked improvement within the first forty-eight hours postoperatively. Later there was a complicating parotitis from which the patient recovered. He did exceptionally well, seemingly convalescing uneventfully, when he suddenly went into shock on the twelfth postoperative day, and expired.

Necropsy. The abdomen showed a clean laparotomy wound. The left inguinal region bulged and contained gas communicating with that in the peritoneal cavity. The peritoneal cavity contained about 2,000 c.c. of purulent fluid and foul-smelling gas. All surfaces of the intestine were covered by fibrin and were adherent to each other. The heart weighed 460 Gm. The lungs showed bronchiectasia, pleural thickening, multiple areas of caseation and calcification (apical).

About 1.2 meters from the duodenojejunal junction a large mass consisting of intussuscepted jejunum was encountered. After the outer layer was opened, the mucosa presented itself in the shape of a tube 30 cm. in length, the lumen of the distal end of which was markedly constricted by an annular, fungating,

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partly necrotic, and ulcerated adenocarcinomatous mass. Ten cm. proximal to the mass there was a slit-like stoma of the recent anastomosis, communicating with the internal cylinder of gut. At one end of the stoma there was a perforation of the wall (8 mm. in diameter) communicating with the peritoneal cavity.

The liver showed fat replacement and a mild degree of cirrhosis. The kidneys had arteriolosclerotic changes and extratubular calcium deposition. The right kidney was hydronephrotic, the prostate hypertrophied.

Anatomic Diagnosis: (1) Carcinoma of jejunum. (2) Jejunojejunostomy wound. (3) Intussusception of jejunum. (4) Perforation of jejunum (operative site). (5) Generalized peritonitis. (6) Benign hypertrophy of prostate. (7) Right hydronephosis. (8) Renal arteriosclerosis and calcinosis. (9) Apical pulmonary tuberculosis (healed). (10) Nodular calcification of pleura. (11) Bronchiectasis. (12) Pleural adhesions, fibrous. (13) Cardiac hypertrophy. (14) Fat replacement of liver. (15) Visceral congestion and cloudy swelling.

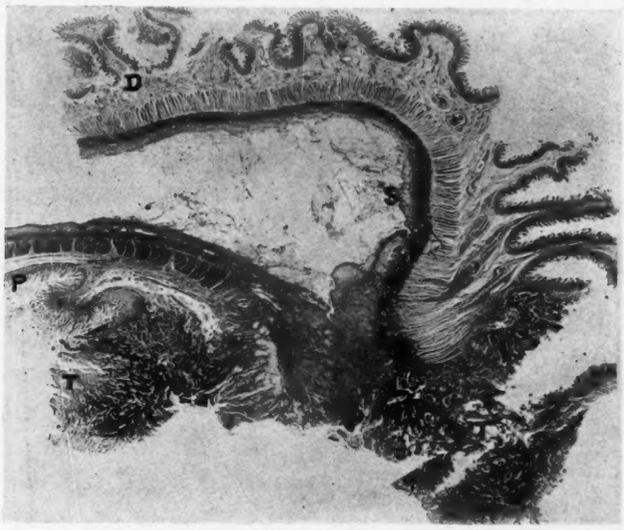

Fig. 2. Low power magnification of the inner loop of intussuscepted jejunum at the site of the neoplasm, showing ulcerative and papillary character of the adenocarcinoma, which marks the site of reduplication of the proximal, P, and distal, D, portions of jejunal wall. The serosa, S, is covered by fibrinopurulent exudate.

DISCUSSION

Carcinoma of the jejunum is rarely encountered, the largest series reported being that from the Mayo Clinic, comprising twenty-one cases up to 1939. A review of the literature to date fails to reveal any case similar to that described above.

The probably pathogenesis of the intussusception and the anatomic relations of the tumor and enteroenterostomy are given in the accompanying diagram. (Fig. 1.) Obstruction was produced by the tumor, and relieved by the subsequent short-circuiting enteroanastomosis. The latter was sufficiently near the neoplasm to be involved in the intussusception.

CONCLUSIONS

1. A thorough review of the literature reveals the infrequency of carcinoma of the jejunum.

2. A case of this condition is here reported which was treated by enteroanastomosis, followed by perforation, generalized peritonitis, and preterminal intussusception.

We wish to express our thanks to Dr. S. H. Polayes, Pathologist of the Cumberland Hospital, for his assistance in the preparation of this report.

SQUAMOUS CELL EPITHELIOMA OF THE VULVA*

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THIS surgical problem in squamous cell epithelioma of the vulva has been well covered by the German writers, but very little attention has been given to this subject in the United States. There is very little in American literature until about 1915. Most of the articles are case reports or reviews of the cases reported in the literature, and many of the case reports are not authentic because there was no biopsy, no surgical pathologic report, and no follow-up record.

Morgagni was the first to write on the subject in 1751, when he reported a case. Mayer, in 1888, reported eight cases from the literature. In 1905, Dittrick reported a study of 135 cases, seventy-five of them studied microscopically. In 1908, Teller incompletely reported thirty-five cases. In 1912, Rothchild reported 331 cases of malignant growths of the vulvae. In 1929, Rentschler of the Mayo Clinic reported seventy-one cases from their records of twenty years. This is a complete and detailed study of the case histories, biopsy, surgical pathology, and follow-up records, either by the clinic, doctor or relatives. Taussig reported 112 cases in thirty-five years, and between 1915 and 1930 reviewed forty-five cases.

Carcinoma of the vulva, compared with other malignant lesions of the female, is quite rare, according to Virchow, representing only 1.35 per cent. Other writers report as follows: Guilt, 1.48; Taussig, 1.20; Mayo Clinic series, 1.25 per cent. Schreiner and Wehr reviewed 118 cases of carcinoma of the vulva in 11,737 malignant lesions. Of these, 108 were in married women, and ten in unmarried women. In 29,000 gynelogic admissions to Johns Hopkins, there were twenty-seven cases of epithelioma of the vulva. Stout reported that there was not a single case in the Presbyterian Hospital in New York City in ten years.

The lesion usually occurs in advanced years, but cases have been reported in most every decade of life, most frequently in the fifth, sixth, and seventh. Like all other epitheliomas, it may vary in degree of malignancy and rapidity of growth and metastasis. The most common pathologic type is squamous cell carcinoma.

Etiology. There are many causes that can be ascribed to as being contributary in character in the etiology of this disease. The ones most frequent are: pruritus, chronic irritation, chronic infection, and leucoplakia. Pruritus of long standing can produce excoriation, abrasions, and pigmentation of the skin which in turn could be an indirect cause. Frank, Rothchild, and the Johns Hopkins authorities consider it the most frequent forerunner. In these series pruritus was present in more than 50 per cent of the cases. Persistent and obstinate pruritus is often a forerunner of trophic changes in all parts of the body. In 1887 Bex wrote on leucoplakia as a cause of malignant changes in the vulva. Taussig considers leucoplakia the most important factor and advises cautery excision for leucoplakic lesions.

The lesion may begin as a simple induration of the dermis, then a small papule develops, which usually breaks down into a small vesicle. It may resolve itself into a hard nodule. Later there may be a fissure and then the lesion develops into one of two types, either a hard nodular or an ulcerative growth. If it is of the ulcerative type, the neoplasm may occur soon after the original induration. The ulcer is usually irregular and raw in appearance.

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Signs and Symptoms. The change may be present for some time before the patient notices it and before any symptoms arise.

After pruritus, the next important symptom is pain. Pain, as in all other malignant lesions is manifested late, or not until ulceration has occurred. It may be burning, stinging, piercing, or lancinating, and often is very sharp. It may be located at the site of the lesion, or can be referred to the hip or the thigh. It is usually aggravated at night or by walking, and in a short time renders the patients bedridden.

In all cases reported, the patients did not seek medical attention until late in the course of the disease, after ulceration has taken place and bleeding has occurred. By this time many cases are hopeless for surgical intervention.

Urinary disturbances may be an early symptom. Incontinence, however, occurs as a late symptom, especially if the tumor is periurethral. After the lesion has existed for some months, secondary symptoms such as secondary anemia, cachexia, lassitude, loss in weight, loss in appetite, loss in strength, and a general physical debility occur.

Metastasis. Metastases are very important as regards the surgical intervention and the prognosis. Blood supply and lymph drainage of the vulva and vagina are abundant, so that metastases occur early and cause the prognosis to be poor. Metastases occur in the inguinal, femoral, pubic, and iliosacral chains. Several cases of metastases to the perineum and gluteal regions have been reported. The inguinal and femoral nodes may or may not be enlarged. If the lymph nodes are palpable, hyperplasia or malignancy is to blame. The lymph nodes are involved in from one to two-thirds of the cases. In Schreiner and Wehr's series of cases the lymph nodes were involved in 62 per cent of the cases and the spread was by direct continuity. In the Taussig series, the lymph nodes were involved in 60 per cent of the cases.

However, the nodes may not be palpable and may yet contain cancer cells, and it is for this reason that radical surgery must be done. Crossen recommends resection of all lymph nodes on both sides, both superficial and deep. Metastasis have been found in the liver, brain, vertebra, lungs, pelvis, and descending ramus of the pubis, etc.

Diagnosis. The patients rarely present themselves early for diagnosis. In the Mayo Clinic series, the time from onset to examination was 1.49 years. This lapse of time accounts for the fact that so many cases are hopeless at the time of examination.

Primary vulvar carcinoma must be differentiated from secondary metastases due to primary lesions in the ovaries, fundus, cervix, or breast. If the primary lesion is in a stage of ulceration, it must be differentiated from chancre, chancroid, condylomata, leucoplakia, and chronic infected Bartholin's glands.

Chancre is differentiated by the brownish color and the definite regularity and circular arrangement. The ulceration is usually more rapid and more painful.

Chancroid has very little resemblance to the ulceration of malignancy. In chancroid the evolution is much more rapid with a larger amount of secretion.

Condylomata have been mistaken for malignancy, but they very seldom, if ever, ulcerate and usually are not painful.

In leucoplakia, the growth is usually slow and there is very seldom any inguinal or femoral adenopathy. Some authors state that as high as 50 per cent of cases of leucoplakia are forerunners of malignant changes. Taussig subscribes to this theory.

A chronic infected Bartholin gland may produce a cystic tumor resembling malignancy.

The Wassermann reaction is a very definite aid in diagnosis and differential diagnosis. If lues is present, it makes the prognosis more unfavorable. In Schreiner's series, syphilis occurred eleven times and these patients all died within a year after the diagnosis was made. Biopsy and microscopic study of tissue are essentials.

Treatment. The type of treatment varies and many factors must be taken into con-

sideration: (1) grade of malignancy; (2) age of patient; (3) the extent of the lesion and metastases; (4) associated lesions; (5) the patient's general physical condition. Surgeons differ regarding the advisability of dissection of the lymph nodes. Rupp believes that both the superficial and deep lymph nodes should be resected as in a carcinoma of the breast. Crossen states that the lymph nodes on both sides, both superficial and deep should be resected regardless of adenopathy. Döderlein, in 1907, stated that if such a procedure was carried out, the postoperative results would be much better.

Basset gave the first description of the superficial and deep inguinal and femoral lymph chains. He advised a two stage operation, first the excision of the inguinal and femoral lymph chains, and two weeks later excision of the tumor mass.

Some authors use the knife, some the cautery, some both knife and cautery. The present day radical method would consist of knife and cautery of the growth, inguinal and femoral lymph nodes, superficial and deep on both sides, to be followed by *x*-ray or radium or both. If recurrence should show up at a later date, they must be treated in the same manner as the original lesion, by cautery and *x*-ray. In Rothchild's series of 225 cases, 111 were operated on without excision of the lymph nodes, and there was a recurrence in seventy-one cases or 63.96 per cent—which is entirely too high. Taussig states that in his series the Bassett operation gave 81 per cent of five year cures while other types of operations gave only a 30 per cent result. These consisted of cautery to the growth, simple vulvectomy, and resection of the superficial lymph nodes.

Taush, in the Tubinger Clinic, reported forty-seven cases in which only fifteen had *x*-ray and radium. Out of this number, only one patient lived three years or more.

Prognosis. The prognosis depends on many factors. If patients come early, the physician is able to handle such lesions with radical resection of the growth, superficial and deep inguinal and femoral nodes on both sides, followed by *x*-ray and radium. One can then hope for indefinite prolongation of a useful life. In most series, the larger percentage of the patients was dead at the end of three years, most of them at the end of the first year. This can be accounted for by the delay in consulting a doctor, incomplete and incompetent surgery, and the abundant blood and lymph supply producing early metastasis. In forty-four of the seventy-one cases in the Mayo Clinic series[13] the time from examination to death was 2.12 years. Thirteen patients were alive and free from recurrence, and their average length of life from the time of examination to the date of the report was 7.77 years.

Welch and Nathanson report 135 patients. Of this number, 25 per cent were dead in seventeen months, 50 per cent were dead in thirty months, and 75 per cent were dead in sixty-five months.

In Schreiner and Wehr's report, 18 per cent of the patients lived five years. If there was no metastasis and only the local growth had to be excised, 42 per cent lived five years. If metastases are present, five year survivals are unusual.

CASE HISTORY

G. K., 38, a housewife, the wife of a baker, reported on July 12, 1928 a tumor mass in the vagina of nine months' duration.

Her father was 73, living and well. Her mother had died at 46 from cancer of the breast. Three brothers and two sisters were living and well.

The patient had begun to menstruate at 13, and the periods occurred regularly at twenty-eight day intervals, lasting four to five days. There had been no pregnancies. Right salphingo-oöphorectomy and appendectomy had been done in 1922.

About nine months before the patient had noticed a small hard mass in the vagina, but paid no attention to it. It gradually increased in size, and about six months before began to discharge; three months before, it began to bleed. At first, the discharge was watery with no odor, but later there was a foul odor and intermittent streaks of blood were noted. For

four to six months the mass had been painful at intervals, especially when much walking was done.

The patient weighed 160 pounds. Her blood pressure was $^{125}/_{80}$, her pulse rate 76, temperature 99.

Numerous lymph nodes were palpable in the left inguinal region. A large mass involved the left labium majus and minus. It was about the size of an orange, with an ulcerated center covered by a grayish-white, foul discharge. The mass extended toward the midline at the symphysis. It was painful on palpation and bled easily. No involvement of the right side was noted. Bimanual examination revealed the uterus to be one and one-half times normal size, but there was no tenderness and no tumor masses were palpable in the adnexa. Leucorrhea, grade 2, was present and two small hard nodules could be seen on the upper lip of the cervix.

Biopsy confirmed the clinical diagnosis of labial carcinoma. Sections showed broad masses and infiltration of columns of atypical epithelial cells. In the superficial portions the cells had a squamous appearance, being fairly uniform in size, shape, and staining. An occasional epithelial pearl was seen, but in the deeper portions the cells were less differentiated, polyhedral and spindle-shaped, varying in size. Some nuclei were hyperchromatic and a few mitotic figures were seen. The stroma was scant in amount, composed of a cellular fibrous tissue heavily infiltrated with round and plasma cells and a few polymorphonuclear leucocytes. The growth was a squamous cell carcinoma.

The urine was cloudy and acid, with a specific gravity of 1.024, a trace of albumin, no sugar or diacetic acid. Much pus and a few bacteria were present. Hemoglobin was 75 per cent; red blood cells 4,210,000; white blood cells 10,949, with lymphocytes 27 per cent, and polymorphonuclear cells 73 per cent. The blood Wassermann was four plus.

The patient was given 0.6 neosalvarsan intravenously for five days.

July 21, 1928, under ether anesthesia, a radical excision of the growth and the left lateral wall of the vagina was done, using the Percy cautery. The resection was extended to the inner side of the thigh and to the spine of the pubis. The wound was left wide open, three curved forceps were left in place, and packing was inserted to stop superficial bleeding.

The pathologic specimen showed several large pieces of fat fibrous tissue and tumor tissue removed with the cautery. The largest measured $4\frac{1}{2}$ by $3\frac{1}{2}$ inches, and the smallest $1\frac{1}{2}$ inches in diameter. Sections showed a squamous cell carcinoma with only moderate differentiation with pearl formation and many mitoses. Another section showed fibrous tissue with areas of round cell infiltration, and groups of glands resembling Bartholin's.

The patient had a splendid convalescence and was dismissed on July 29. On the fourteenth day postoperative, there was a secondary hemorrage which was controlled by packing. On November 4, 1928, the patient entered the Methodist Hospital and on the following day, under ether and nitrous oxide anesthesia, by knife and cautery, a wide dissection of the inguinal, femoral and public lymph nodes was done. The cautery was applied to a small granulating area at the site of the original operation. Three Penroes drains were left in place.

The several masses of fibrofatty tissue contained many large and small soft, cellular glands. Sections from one of these glands showed masses of enormous cells, irregular in size and shape, many having hyperchromatic nuclei and mitotic figures. Areas of round cell infiltration were seen in scant stroma.

The patient was dismissed from the hospital November 25.

Between May 7 and May 17, 1929, a total of 600 r. was given anteriorly and posteriorly to the pelvis. On October 3, 1929, a flat radium pack was made and placed against the cervix and held in place with gauze which also pushed away the bladder and rectum; 100 mg. of radium was used and filtered through 1 mm. of lead and 2 mm. of rubber and backed by 2 mm. of lead. This was left in place for twenty-six hours for a total of 2,600 mg. hours of radium. On January 2, 1931, 1,440 mg. hours of radium was applied to the cervix. On November 31, 1931, there was no evidence of malignancy in the cervix, vagina, femoral or inguinal lymph regions.

On July 1, 1937, the patient returned for a check-up examination, and reported that she was working in the alteration department of a large department store. She was feeling well. The general examination was essentially negative except for a slight edema of the left thigh and leg. There was no evidence of

recurrence of the growth in the vagina, cervix, uterus or on the opposite side.

SUMMARY

1. A case of squamous cell epithelioma of the vulva is reported.

2. The most frequent symptoms of this type of cancer are pruritus, pain, bleeding, discharge, and the secondary symptoms of cachexia.

3. Right and left sides are almost equally involved in all the series reported.

4. The treatment should consist of excision of the growth with the cautery, and dissection of the femoral, inguinal and pubic lymph nodes, both superficial and deep with knife and cautery.

5. *X*-ray and radium should be given as adjuncts in the postoperative treatment, never as the sole treatment unless the case is inoperable or secondary metastasis makes surgical intervention inadvisable.

6. If early surgery is carried out, an indefinite prolongation of life can be expected, but a cure cannot. These patients should be under frequent examinations in order to observe any early metastasis.

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LIPOMATA OF THE UTERUS*

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LIPOMA of the uterus as a pure lipoma is of extreme rarity. Even mixed tumors containing fatty elements, while occurring more often than the pure lipomas, are by no means frequent. When the number of lipomas in all the fatty structures of the body and the perhaps greater frequency of tumors of the uterus is considered, the rare occurrence of true lipoma in the uterus is striking. The reason seems to lie in the very limited amount of fatty tissue in the uterine structure where it appears only in extremely small amount about the blood vessels. The clinical importance of lipoma is not of the greatest moment but the number of reported cases is so small that each case may add to the bulk of our knowledge and its study may help the solution of the problem of the cause and pathogenesis of tumor growth.

The uterus has long been recognized as a frequent site of the development of neoplasms. Ellis, 1906, mentions the study of 13,824 patients of both sexes treated in four large London hospitals because of primary new growths. Of these patients 9,227 were women, and 28.7 per cent, or 2,649, suffered from tumor of the uterus. Ellis in the same report states that Gurlt, in 13,971 tumors analyzed at Vienna Hospital, found 4,115, or 29 per cent, to be uterine in location. No mention is made of a lipoma in the series of Williams, which may be considered as fairly representative. A total of 2,649 cases were recorded: cancer 1,571; myoma 883; nonmyomatous polyps 191; sarcoma 2; cystoma 2. Nor, in fact, does Ellis leave one to conclude that Gurlt's report shows such a case. Seydel (quoted by Ellis) found only four cases of true lipoma of the uterus reported up to 1903, and only one of the four compared in size and location with the specimen reported by Ellis. He states that two of Seydel's cases were tiny cervical polyps and the third was a subserous growth the size of a cherrystone. There were, in addition to these four cases of lipoma, two of lipomyoma and four of lipofibromyoma on record. Still one other case in Lebert's Atlas is designated simply as adipose tissue. Seydel accepts only these eleven cases as authentic lipomatous tumors of the uterus, rejecting three cases cited by Knox because they were not examined microscopically. However, at least two of these latter cases appear from their gross description to have been lipomas or lipofibromas. From the reason given, Seydel appears justified in excluding them from his list.

Ellis gives the list of Seydel's cases and states that he has verified all but two which he made no attempt to trace.

1. The theory that they result from a fatty degeneration of the fibrous or muscular tissue in fibromyoma of the uterus. In support of this it has been urged that fatty degeneration has been observed in the muscle cells and the connective tissue of these fatty tumors, and one author believed that he could trace the process in its various stages from beginning fatty degeneration to completed fat cell. This idea is contrary to the present ideas of the specificity of tissue growth. Moreover, some of the tumors have shown no fatty degeneration, whatsoever, in the connective or muscular tissue.

2. The theory that the fat cells arise by multiplication of fat cells congenitally misplaced.

3. The view that the fat cells arise by multiplication of the fat cells brought into the uterus along with the blood vessels.

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Ewing mentions a case of polypoid lipoma observed by Orth, also two cases of intramural uterine lipomas reported by

FIG. 1. Photograph of opened uterus, posterior view. The fatty tumor of the fundus protrudes from the sectioned surface. The cornua are elongated. The mucosa is hemorrhagic and papillary.

Merkel, while lipomatous areas of mixed tumors of the uterus are mentioned by Gerlach. Pollack thought his intrauterine lipoma originated from a portion of omentum protruding into a wound of the uterus.

Lund reported to the New England Surgical Society in 1933 an unusual case of uterine lipoma complicated by gallstones.

Arthur A. Humphrey and Russell L. Mustard report a fatty growth about the size and shape of a large cherry accompanying and adjacent to, but separated from, an ulcerated carcinoma of the cervix. About an inch above the ulcerated cervix the yellow fatty intramuscular mass protruded through the surrounding myometrium. Sections through the yellow tissue showed a typical adipose tissue structure which appeared quite sharply demarcated from the myometrium. According to the authors, several points of interest present for consideration in this case, first because of a fifteen year cure of a breast carcinoma with auxillary involvement, and second because it may in a measure explain the genesis of lipoma as well as acanthoma in this site.

Ewing states that a variable histogenesis may occur in adenocanthoma of the cervix but that those in the uterus may be on the basis of metaplasia in almost all instances and do not require heteroplasia of squamous cells. While transition from adenomatous tissue to squamous celled structure has been long recognized and is frequently seen in the cecum and elsewhere, the idea that a similar metaplasia changes epithelial structure into lipomatous tissue is somewhat remote. It appears more likely that a single heterotopic focus may have carried all of these tissue structures.

CASE REPORT

Mrs. L. T., 63, a white widow, was admitted to the hospital January 18, 1939.

She was the mother of five living children. Her menopause at 45 had been uneventful. She had no unusual discharge until one week before examination, when a moderate amount of vaginal bleeding suddenly appeared and continued for two days, followed by spotting for five days. Mild cramp-like lower abdominal pains accompanied the bleeding.

The patient was well developed, weighing 159 pounds. Her blood pressure was 190/88, the Wassermann negative and the urine negative. Hemoglobin was 84 per cent; color index .9; erythrocytes numbered 4,490,000; leucocytes 9,600; polynuclear neutrophiles 70 per cent; lymphocytes 28 per cent; monocytes 2 per cent.

A moderately enlarged but smooth cervix was noted at the vaginal introitus. There was a second degree procidentia with a slight blood tinged discharge from the os, but on introduction of a sound into the cervical canal no bleeding was precipitated. Bimanual palpation disclosed a slight but smooth enlargement of the fundus uteri, which was freely movable without tenderness or presence of adnexal masses. A diagnosis of possible early carcinoma of the fundus with procidentia was made and vaginal hysterectomy recommended.

At operation, January 20, 1939, under subarachnoid anesthesia, the uterus with a round soft intramural fundal tumor was removed, and

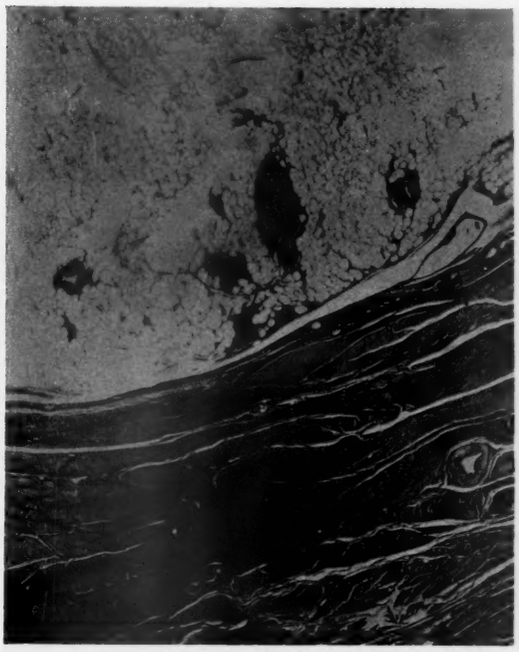

FIG. 2. Photomicrograph of uterine muscle and embedded lipoma. There is some pressure atrophy about the tumor and a cleavage space outside the capsule.

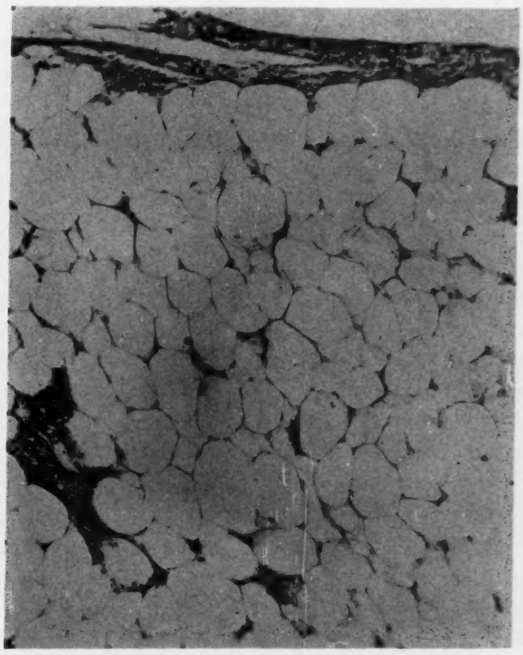

FIG. 3. Photomicrograph of tumor in the fundus. The fibrous connective tissue capsule, trabeculae and the adult type fat cells are shown.

FIG. 4. Photomicrograph of endometrium and a portion of a papillary mass. The endometrium is atrophic and glands are cystic.

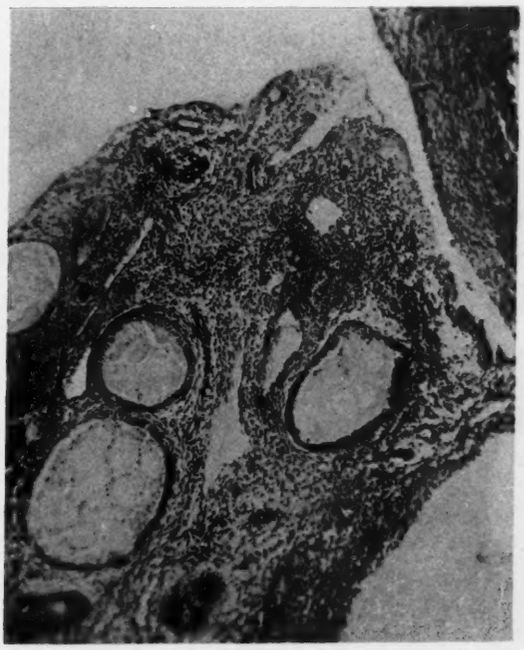

FIG. 5. Photomicrograph of portion of endometrial polyp. The structure is similar to that of the endometrium. The stroma contains lymphocytes and erythrocytes. The glands are distended with secretion. The surface epithelium is denuded.

a plastic repair of cystocele followed. An uneventful convalescence followed. The patient was discharged from the hospital on the fourteenth postoperative day.

The pathologic report (by Dr. A. J. Miller, professor of pathology in the University of Louisville) was:

The uterus measured 11 by 7 by 5 cm. and was opened longitudinally on its posterior aspect. (Fig. 1.) Embedded in the muscle of the fundus was a spherical tumor 3.5 cm. in diameter. This mass was under some tension, well encapsulated, and had the color, consistency and trabecular markings of a lipoma. It distorted the cavity of the uterus slightly by pushing the fundus down, but the muscle completely surrounded the mass.

The mucosa was thin except for irregular papillary elevations 3 to 15 mm. in diameter and 3 to 7 mm. high. There were innumerable retention cysts in the mucosa, both in the atrophic portion and the papillary elevations, varying in size from those barely visible to some 3 mm. in diameter.

The cervix was fissured and scarred and some of the glands were cystic.

The muscle over the body was 2 cm. thick. Numerous sclerotic arteries protruded from the sectioned surface.

Embedded in the muscle of the anterior wall, just above the internal os, were two hard, spherical encapsulated tumors, each 15 mm in diameter. These had the appearance of leiomyomas.

Sections of the tumor at the fundus showed it to be made up of fat tissue. (Figs. 2 and 3.) There was a thin fibrous connective tissue capsule continuous with trabeculae extending into the mass. The parenchymal cells were well differentiated fat cells.

The mucosa was atrophic, consistent with senility, the stroma fibrotic, infiltrated diffusely with lymphocytes. There were numerous hemorrhages, some recent, to be attributed to manipulation. There was some partly disintegrated blood and blood pigment, indicating hemorrhage. The glands were atrophic, many of them distended with secretion and a few invaded by monocytes. The papillary elevations were similar in structure and inflammatory reaction. (Figs. 4 and 5.) The surface epithelium was partly eroded.

Sections of the tumors in the body wall revealed a structure of smooth muscle similar to that of the uterus and a moderate amount of connective tissue stroma. There were some small, dense deposits of calcium salts about which there was degeneration.

No evidence of malignancy was noted in the tumors or the mucosa. The diagnosis was: (1) intramuscular lipoma of fundus uteri; (2) intramuscular leiomyomas of corpus uteri; (3) senile atrophy of mucosa; (4) polyposis (papillary adenomas) of mucosa with chronic inflammation and hemorrhage.

SUMMARY

1. A rare tumor of the uterus, a true lipoma is reported, the fourth in Anglo-American literature.

2. Two leiomyomas, polyposis (papillary adenomas) of mucosa and a true lipoma are described as occurring in the one uterus.

The author wishes to express his indebtedness to Dr. A. J. Miller, professor of pathology in the University of Louisville School of Medicine, for his excellent pathologic description and photomicrographs.

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TRIPLE PRIMARY MALIGNANCIES

CASE REPORT

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THREE separate primary malignant tumors were demonstrated in a sickly epileptic female 44 years of age who, nevertheless, died from other causes. Cases of more than two malignancies in the same patient are rare, and those found are usually in individuals older than 44 at the time of death.

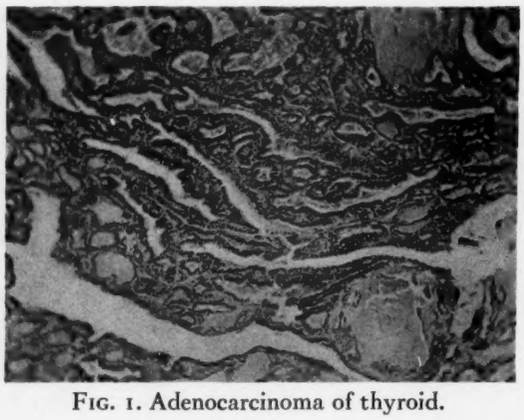

FIG. 1. Adenocarcinoma of thyroid.

In the diagnosis of multiple malignancy, the most widely accepted criteria are those advocated by Hanlon: (1) the tumors must have the macroscopic and microscopic appearance of the usual tumors of the organs involved; (2) probability that one tumor is a metastasis must be definitely excluded; and (3) the diagnosis may be confirmed by the character of the individual metastasis. In the following case report these criteria seem fulfilled.

The patient, a 44 year old unmarried woman, had been feeble-minded since birth. She had had chorea as a child and epileptic attacks since the age of 25.

In the summer of 1936 she first complained of a painful nodule in the left breast of one year's duration. There was a slight discharge from the nipple and her sisters volunteered the information that she had lost about 20 pounds in weight. The left lobe of the thyroid was firm and nodular. There was a fine tremor of the tongue and rather coarse tremors of the extended fingers. The temperature, pulse and respirations were normal. The blood pressure was 140/70. *X*-ray examination of the chest failed to reveal evidence of metastasis.

FIG. 2. Tumor of left ovary (post-mortem).

On August 31, 1936, a radical left mastectomy was performed. The anatomic diagnosis on the removed breast was acinar carcinoma (carcinoma simplex). She made an uneventful surgical recovery and was discharged from the hospital September 21.

On February 10, 1937 she was readmitted with the diagnosis of thyrotoxicosis. After all attempts to reveal evidence of breast metastasis failed, the patient was subjected to a thyroidectomy on February 13. The anatomic diagnosis on the removed thyroid was adenocarcinoma. Again she made an uneventful recovery and was discharged from the hospital on February 28.

On August 9, 1938 she was readmitted with the history of having fallen out of bed several days previously. Her temperature was 103, her pulse 135, her respirations were shallow and numbered 32. The red count was 3,500,000, the white count 12,000, with 80 per cent polymorphonuclears. There were numerous râles in the left lower chest and the diagnosis of pneumonia was made. Despite all medication she grew steadily weaker, her breathing became very shallow and she expired August 14.

On post-mortem examination there was no evidence of recurrence of either of the two malignancies found during life. There was, however, a primary malignancy in both ovaries with metastases to the abdominal lymph glands. The left ovary was replaced by a large, rounded tumor measuring 10 cm. in diameter. The right ovary was the site of a smaller but similar tumor nodule measuring 2 cm. in diameter. Microscopic sections of these tumors revealed the very cellular picture called embryonal cell carcinoma. The left lower pulmonary lobe was airless and presented the typical picture of lobar pneumonia.

COMMENT

Many multiple malignancies have been reported; among these, triple cancers are rather rare. McNamara reported three distinct malignancies in addition to a basal cell carcinoma; Davis, Hanelin and Mouzakeatis reported a case of triple tumor syndrome in a 57 year old male; Drooker reviews the statistics of Warren and Gates in which triple primary malignancies comprise 2.9 per cent of all cases of multiple malignancies. Hanlon added forty-nine cases of double primary carcinoma to those seen at the Mayo Clinic but failed to find any case with three primary malignancies. Murray, in studying 4,219 cancer cases, found multiplicity in 1 per cent; Puhr, in 6,718 necropsies, found multiple malignancies in only 0.3 per cent, while Burke, in 2,033 necropsies, found an incidence as high as 7.8 per cent.

The average ages of patients with these multiple lesions were as follows: Hanlon reported an average of 55.8 years, and in twenty-four cases involving three or more organs in his own series, 62.6 years; Owen reported an average of 62.1 years; Hurt and Broders, 50.4 years.

Exclusion of the probability that one tumor is a metastasis is often difficult. Reports of multiple malignancies in the breasts are open to criticism, because of the strong probability of metastasis. Similarly in cases where primary gastric and primary ovarian cancers are reported the question of metastasis arises because of the frequent spread of gastric carcinoma to ovaries. Multiple ovarian tumors, too, are questionable because of the difficulty in differentiating between primary origin and metastasis. A further complication in eliminating the factor of metastasis is the fact that a recurrence may occur many years after the apparent cure of a primary malignancy.

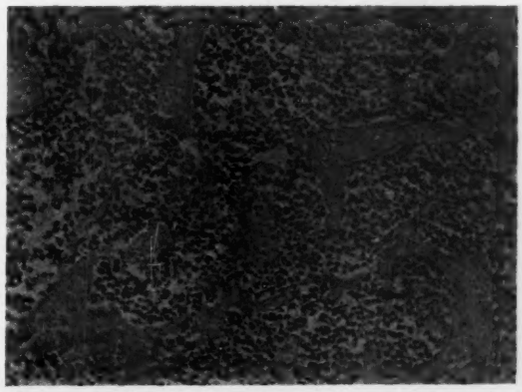

FIG. 3. Embryonal cell carcinoma of ovaries (post-mortem).

CONCLUSIONS

While multiple primary malignancies are not extremely rare, the case here presented is of interest because of three separate primary malignancies in an individual 44 years of age who had always been a semi-invalid. Despite the history of illness since birth, epileptic attacks since the age of 25, carcinoma of the breast, carcinoma of the thyroid and carcinoma of both ovaries found at post-mortem, this patient lived to be 44 years of age and die of pneumonia.

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NEW OPERATION FOR RELIEF OF INCREASED INTRACRANIAL PRESSURE IN HEAD INJURIES

CASE REPORT

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OPERATIONS on head injuries are recognized as useless and dangerous procedures except when patients have massive intracranial hemorrhage. The sequence of events in the following case has suggested that perhaps we may be able to help more of these patients by surgery in the critical stages.

FIG. 1. Basal skull fracture on the right crossing lateral sinus and region of the posterior occipital artery.

FIG. 2. Basal skull fracture on the right crossing lateral sinus and region of the posterior occipital artery.

CASE REPORT

D. B., 7 year old boy, fell from a bicycle, striking the pavement on the right occiput. The patient was immediately rendered unconscious, regained consciousness in a few minutes, then lapsed into semiconsciousness within another few minutes. His pulse was slow and regular and of good quality. There was vomiting of blood and bleeding from the nose and right ear. There was a large skull fracture in the right base and occiput, across the longitudinal sinus and the region of the posterior occipital artery and also a small linear fracture entering the groove of the middle meningeal artery in the left middle fossa. (Figs. 1, 2 and 3.) There was a large ecchymosed and swollen area behind the right ear and down the right side of the neck, accompanied by ecchymosis of the left eye and cheek. A right conjugate deviation of the eyes was noted. Pupils were equal and regular and reacted well to light. The pulse became 94 and irregular. Blood pressure was 110 over zero.

Biceps, triceps and radial reflexes, when obtained, were equal. Abdominal reflexes were absent. Cremasterics were absent. Patellars were diminished and equal. Achilles reflexes were diminished and equal. Plantar reflexes were normal. There was no paralysis or sensory disturbance.

The patient resisted weakly all examination, especially the scratching of the abdomen, thighs, and the soles of the feet. He answered

FIG. 3. This fracture runs up into the groove of the middle meningeal artery which can easily be seen in the left middle fossa. Such a fracture can be the etiologic factor in an extradural hemorrhage. Photographer in attempting to bring out clearly the small linear fracture has brought out only part of it.

questions with great hesitation but correctly. The condition was satisfactory considering the severity of the trauma although the prognosis was grave. Treatment was non-intervention and a restriction of fluid intake.

In the next forty-eight hours observation indicated that recovery would not take place. The pulse moved downward, with periods of irregularity and poor quality. Dehydration therapy was instituted by magnesium sulfate enemas and intravenous dextrose. Spinal puncture revealed a slightly bloody fluid at a pressure of 400 mm. The fluid did not flow freely after 5 c.c.

Because of the number of cases of massive hemorrhage which are undiagnosed, this condition was suspected and diagnostic trephines were advised. Surgical intervention was delayed as localizing signs were not definite enough. The pulse remained low and irregular. (Fig. 4.)

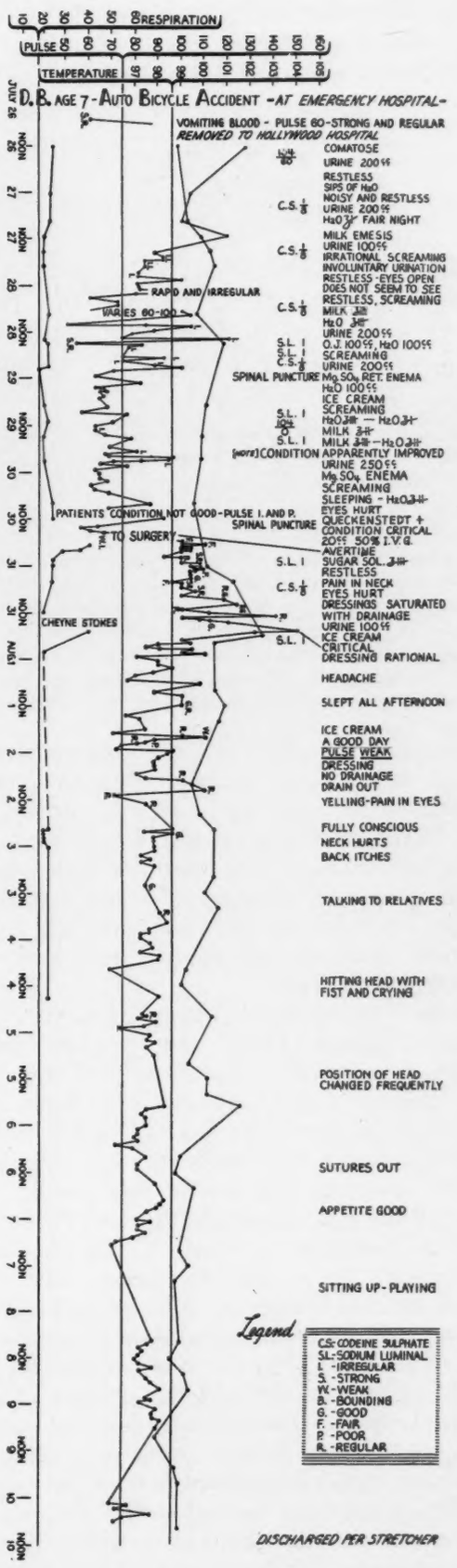

FIG. 4. (Graph at right.) D. B., age 7, July 26, 1938. Explored July 30 for possible massive hemorrhage and recovered with drainage in the cisterna magna. The critical condition on July 31 was due to too intensive dehydration. Before surgery, "I" over pulse counts indicates irregular. After surgery note that pulse counts are F, fair; SR, strong and regular; GR, good and regular.

On the fourth day the pulse had been below 60 twice, was weaker and often irregular. Repetition of the spinal puncture revealed a pressure of 175 mm. and a complete block, which, because of bulbar symptoms, was thought to be in the region of the foramen. It was feared that the patient would die and operation was done. The operative plan was to trephine for the discovery of massive hemorrhage. The possible locations were the right occipital area, the left frontal area, and the right posterior fossa.

A small trephine hole was made in the right occipital region. There was no hemorrhage either extradurally or subdurally. The brain was pressed tightly against the dura and pulsations in the brain were faint. An unsuccessful attempt was made to tap the right lateral ventricle. The wound was closed. The floor of the right posterior fossa was exposed with a horseshoe incision. A trephine hole was made. No extradural hemorrhage was noted, but the brain was found pressed tightly against the dura. No spinal fluid escaped and pulsations were faint. It was decided that a drain placed in the cisterna magna might relieve pressure, and this was done by means of a blunt-ended grooved director. Considerable clear spinal fluid escaped. With the escape of this spinal fluid the patient's pulse, which had been running 120 and irregular during the operation, fell to 90 and became regular. A flat ½ inch rubber drain was passed into the cisterna magna and carried out the upper end of the wound. The wound was closed. As the patient's condition was so much improved it was decided that he was well enough to be returned to bed without further exploration and this was done. The patient left the table in far better condition than before the operation.

The next morning the entire bandage was saturated with spinal fluid; the patient was conscious and rational. That afternoon toxic dehydration occurred with a pulse of 150 and Cheyne-Stokes respiration. The intake of fluids was increased and this critical condition disappeared. A dry dressing was applied. The patient's condition remained satisfactory. Pulse was strong and regular. On the second postoperative day the drain was removed. The subsequent recovery was uneventful. The patient was discharged and kept in bed for six weeks. He has remained perfectly well.

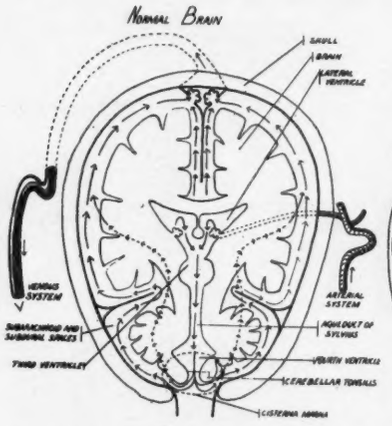

FIG. 5.

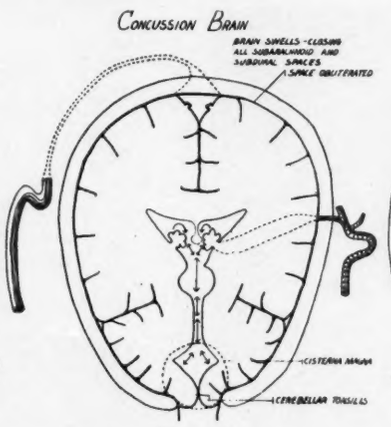

FIG. 6.

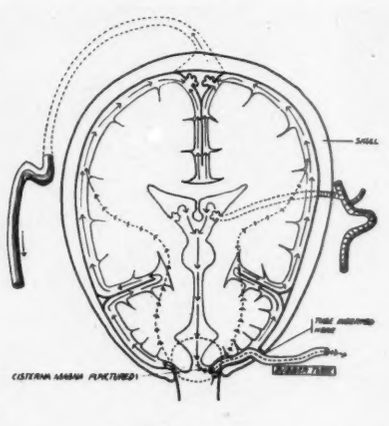

FIG. 7.

FIG. 5. Normal brain: Secretion from the choroid plexus in the ventricles. It finds its way through the subarachnoid spaces to the channels of absorption. There is much controversy as to where these are. However, the most accepted view is that they are in the pacchionian bodies.

FIG. 6. The concussion brain: All channels of absorption are mechanically blocked off by the obliteration of the arachnoid spaces. In such a condition all capillary vessels must be greatly compressed. Neither adequate blood supply nor adequate spinal fluid circulation could take place to repair damage.

FIG. 7. Schematic drawing of our drain in the posterior fossa, reestablishing spinal fluid circulation and relieving pressure by drainage of the ventricles.

Exploration was made for an extradural or subdural hemorrhage in the right posterior fossa and recovery was due to drainage in the cisterna magna. The recovery was remarkable enough to analyze for presentation as an alternative method of reducing increased intracranial pressure in head injuries, dehydration and spinal puncture failing.

Ody[1] of Geneva, Switzerland advocated an atlanto-occipital trepanation in 1932. He reported two cases with excellent results. The sequence of events in his cases was remarkably similar to the sequence of events in this one. He operated in the face of an apparently hopeless condition, with bad pulse and respiration, and upon drainage of the cisterna magna there was an immediate improvement and subsequent uneventful recovery. His operation approaches the cisterna magna through the midline by removing the intervening parts of the spinal canal. He places a drain in the cisterna magna at the foramen. The principles of the two procedures are the same.

The operation done here was a small trephine hole in the floor of the posterior fossa with the insertion of a rubber drain into the cisterna magna. This allowed release of pressure, readjustment of the spinal fluid circulation and decompression of the brain by drainage of the ventricular system.

Schematic drawings (Figs. 5, 6 and 7) illustrate the normal spinal fluid circulation, the blockage which takes place with an edematous brain, and the approach used.

This is possibly the simplest and most logical way to decompress the brain, other methods failing. It is submitted as a neurosurgical procedure that warrants further investigation.

SUMMARY AND CONCLUSIONS

1. In a critical head injury patient a drain was placed in the cisterna magna and immediate relief of increased intracranial pressure took place.

2. The method was used incidental to a negative exploration for suspected massive hemorrhage.

3. The logic of the procedure is illustrated by three schematic drawings.

4. An analogous operation by Ody is discussed.

5. The case illustrates a strictly neurosurgical procedure that warrants further investigation.

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A CASE OF HYPERPARATHYROIDISM ASSOCIATED WITH EXTREME DENTAL CARIES

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HYPERPARATHYROIDISM is a rare disease. Wilder and Howell accepted as proved only 135 cases reported in the literature from 1925, the time of Mandl's description of the condition, up to June, 1935.

The diagnosis is relatively easily made provided the condition is suspected and proper laboratory procedures are carried out, namely *x*-ray examination of the bones, and determination of the serum calcium, phosphorus, and phosphatase. However, because the symptoms of the disease are protean and many of them not distinctive, it often goes undiagnosed. The frequently encountered lethargy, atonia, and polyuria can hardly be counted on to direct attention to the possible presence of hyperparathyroidism, but when there is a history of fractures from slight trauma, or the presence of bone pain, bone tumors, or renal lithiasis, one should always investigate for this condition.

The following case is reported because the presenting symptom, namely dental caries, had not to our knowledge been encountered previously in the recorded cases of hyperparathyroidism.

The patient was a married woman, aged 33 years, complaining of widespread dental caries. The history showed there had been a certain amount of bone pain present since childhood, especially involving the right hip and the pelvic girdle. During each of three pregnancies, nine, eleven and thirteen years before, there had been increased pain in the pelvic bones and trouble with the right hip. There had also been pain in back and shoulders. Eleven years before, while pregnant, she had probably fractured a rib by lifting her 2 year old baby and more recently she had had a possible fracture of the eleventh rib on the left following a slight trauma.

There was a profound sense of fatigue and inability to get enough sleep. The patient stated that she could sleep fourteen to sixteen hours a day. Her appetite was exceptionally good. At times she complained of burning pain in her abdomen when hungry. There was no constipation. She showed increased susceptibility to colds and bronchitis. The menses had been quite normal.

For years, on the advice of her dentist, she had been in the habit of drinking milk, and taking calcium and cod liver oil.

The family history disclosed that there were twelve cases of carcinoma of various organs of the body in the paternal line, while in the maternal line there were many cases of tuberculosis, but there was no record of any bone disease.

On examination the temperature was 98.6°F. The blood pressure was 116/82. The most striking finding was the extreme caries involving every tooth, many of which were riddled with multiple cavities. The tonsils were large, cryptic, and contained fluid pus. The breasts were small, the left showing an inverted nipple and the right a tender nodule. The left eleventh and twelfth ribs were sensitive to pressure and there were tender points along the crests of both ilia. The reflexes seemed about normal and there was no evidence of hypotonia.

The hemoglobin was 90 per cent. The urinalysis was negative. The serum calcium was 15.0 mg. per cent, the inorganic phosphorus 2.5 mg. per cent. Roentgen ray examination of the chest, ribs, cranium and pelvis showed no evidence of osteitis fibrosa cystica, but there was moderate osteoporosis especially involving the ischial rami and the bones of the skull were definitely thickened. A diagnosis of hyperparathyroidism was made and operation advised.

At operation only one parathyroid gland could be demonstrated on each side, although an extensive dissection was carried out extending down into the mediastinum from which a small piece of the thymus was removed. Both of the parathyroid glands appeared only slightly enlarged. The one on the left was removed; the one on the right was preserved. At the same time a subtotal thyroidectomy

was also done, removing about five-sixth of each lobe; no parathyroid tissue was found in the resected lobes.

The patient made an uneventful recovery. The serum calcium had dropped to 10.0 mg. per cent on the fourth postoperative day. Following operation all bone pain disappeared and the former lethargy was replaced by irritability, nervousness, and emotional unbalance. The deep muscle reflexes became hyperactive but no Chvostek or Trudeau phenomena appeared. Four weeks postoperatively, while these symptoms were at their height, the blood calcium was still found to be 10.0 mg. per cent and the phosphorus 2.9 mg. per cent. The hyperirritability promptly subsided on administration of cod liver oil and calcium. Whether or not the dental caries will be checked remains to be determined after the passage of time.

We believe the diagnosis of hyperparathyroidism is justified in this case even in the absence of marked typical changes in the bones because of the preoperative hypercalcemia and hypophosphatemia, the return of the serum calcium and phosphorus to normal immediately after removal of the parathyroid tissue, the replacement of lethargy and hypotonia by an abnormal irritability which was relieved by calcium administration. It seems likely that the disease had been present for a long time without greatly injuring the skeleton because of the protective effect of the self-administered calcium and cod liver oil, for it has been shown that administration of vitamin D and calcium tends to prevent skeletal decalcification, while at the same time encouraging high serum calcium and calcinosis.

Churchill and Cope have recently reported on six cases of hyperplasia of the parathyroid glands without tumor. This case probably falls into the same category. While these tumors are often hard to find at operation and while in some cases tumors have been found only after repeated explorations, the fact that such a thorough exploration was done in this case without finding a tumor, coupled with the fact that after removal of one parathyroid gland the serum calcium and phosphorus returned to normal and all symptoms disappeared, leads us to believe that the condition was one of hyperparathyroidism due to hyperplasia of the parathyroid glands.

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INTRA-UTERINE RETENTION OF THE DETACHED FETAL HEAD

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INTRODUCTORY NOTE

THE case reported herewith emanates from that great area of northern Arizona, northwest New Mexico and southern Utah known as Navajoland. This area comprises about 50,000 people and 16,000,000 acres of land.

These Indians are nomads, living in crudely constructed hogans, tending their herds of sheep and following the range. They have their medicine men who dance and incant before the sick to dispel the evil spirits of illness. Often it is only after failure of this ministration that the patient is brought to the Government hospital. The medicine man also acts as obstetrician as will be noted in the following report.*

Intra-uterine retention of the detached fetal head is perhaps the most rare of the many possible complications of breech delivery. Most textbooks do not mention this accident and I have found no record of its occurrence during delivery performed by a physician.

The index catalogue of the Army Medical Library cites only one case; this occurred in a neglected breech unattended by a medical man. Plauchu presented this case before the National Society of Medicine of Lyon, France in June 1913, and reported it in the *Lyon Médical* of that year. He states that during extraction of the aftercoming head, separation may occur due to the arrest of the head by obstacles of the bony pelvis or muscles, or because of great size of the head as in hydrocephalus. It may also occur from too great forceps traction upon the head in cephalic presentations. Separation rarely occurs while the infant is alive, but after death the tissues become friable and are more easily torn.

He was called to attend a woman with a retained fetal head, which he found in the fundus. It was easy to introduce one hand into the uterus, seize the stump of the neck with three-pronged forceps and bring the head down to the perineum. He then completed the extraction with the Mauriceau or Smellie-Veit maneuver. He states that extraction might also be done with ordinary obstetric forceps and, if necessary, reduction of the head by craniotomy or basiotripsy. If the uterus is so strongly retracted about the head as to prevent extraction he recommends total hysterectomy.

REPORT OF CASE

Labor had commenced four days before admission. That morning the breech presented and a medicine man of the tribe, assisted by the husband, tried to do an extraction. I do not know how long they pulled, but finally the body was torn from the head and a "Sing" was started. After some time the hospital was called and my associate, Dr. Safran, arrived while the "Sing" was in progress. He found the patient lying on a blanket in the hogan with the cord issuing from the vagina and not tied. Upon inquiring about the body of the baby he was informed that it was buried and found it in a pinion tree wrapped in rags.

Physical examination upon admission revealed an emaciated Navajo primipara, 35 years old, with temperature 98.4, pulse 80, blood pressure 120/80. She was in fair general condition. The uterus was not contracted and the fetal head was palpated in the epigastrium. The labia were very edematous, the umbilical cord protruding. Pelvic measurements were: isp. 24 cm.; icr. 26 cm.; bit. 29 cm.; ext. conj. 18 cm.; diag. conj. 11; bi isch 7. DeLee gives the normal as 26, 29, 31, 20, 13, 10 respec-

* Opinions expressed herein are those of the author and do not represent any official policy of the Office of Indian Affairs, U. S. Department of the Interior.

tively. Thus, this pelvis was contracted and funnel in type.

Operation was performed under ether anesthesia. The cervix was dilated but not effaced, the lips being edematous and lacerated. The sacral promontory projected far into the pelvis so that the hand passed with difficulty. The head was felt high in the fundus and the placenta was in situ.

FIG. 1.

FIG. 2.

FIG. 1. Body of fetus after being pulled away from intra-uterine head.

FIG. 2. Fetal head after extraction.

The soft parts were dilated with the hand. An attempt was made to use obstetric forceps but this was unsuccessful because of the deformity of the pelvis and the floating characteristic of the head. The cranioclast was tried, but the guiding hand and this instrument could not pass the sacral promontory together. By external pressure and internal maneuver the head was brought to the brim of the inlet. A finger was hooked under the mandible which was grasped by a tenaculum. The head would not pass and a piece of mandible came away. The skull was finally perforated with the tenaculum and considerable brain tissue evacuated with a finger. Grasps of the tenaculum took away small pieces of the head and at last a combination of external pressure and traction by the internal hand served to evacuate the head. The placenta was extracted manually without difficulty. A first degree laceration of the perineum was closed with three catgut sutures.

Twice during the operation the patient appeared weak and was given 7½ gr. of caffeine sodium benzoate. The immediate postoperative condition was fair and 1000 c.c. of 5 per cent dextrose in saline was given intravenously. Four hours postoperatively, the temperature was 101.4 and the pulse 110. The course continued septic for seventeen days, with the temperature varying between 103.4 and 98 and the pulse from 124 to 78. On the fourth day, the pulse was imperceptible and the blood pressure could not be read. An injection of 1 c.c. digifortis was given and tincture of digitalis, 1 c.c., administered by mouth every four hours. Fluidextract of ergot, 4 drams daily, was administered for seven days and sulfanilamide 60 gr. daily for seventeen days.

FIG. 3. Patient when ready to leave hospital.

Blood count on the fourth postoperative day revealed hemoglobin 70 per cent; R.B.C. 4,260,000; W.B.C. 29,400; polys 87 per cent; lymphocytes 13 per cent. The Wassermann and Kahn tests were negative. On the seventh day there was considerable abdominal distention which was relieved with pituitrin. On the ninth day sulfanilamide was suspended for three doses. That evening the patient had a severe chill with temperature of 103.4°F. Sulfanilamide was again given; the temperature was 99 the next afternoon and then continued up and down for the next week.

Vaginal examination on the sixteenth day revealed a mucopurulent cervical discharge; the lacerations were healed and the cervix firm. The uterus was retracting but the parametrial tissues were indurated and fixed. A large, apparently decubital, area was noted on the right buttock, although all precautions, such as use of a bed-ring, had been taken. This area had softened and become fluctuant on the eighteenth day. It was opened and drained under evipal anesthesia. At this time daily warm potassium permanganate douches were started and given for about three weeks. Fourteen days after opening the abscess, the cavity had become clean and stopped draining. Under local anesthesia the cavity was curetted, the wound edges freshened and obliterating sutures inserted. Eight days later the sutures were

removed and the wound treated daily with the infra-red lamp. The patient was allowed out of bed, and on her fifty-second hospital day was discharged. Final vaginal examination showed the cervix normal in appearance, the uterus anteflexed but drawn to the left and not freely movable. There were no adnexal masses or tenderness. A slight vaginal discharge was present.

SUMMARY

The literature and etiology of intrauterine retention of the detached fetal head in breech presentation is reviewed. An abstract is given of the only previously reported case.

A case in an Indian primipara on the Navajo Reservation is reported.

The head was extracted with great difficulty, and then only after perforation, due to disproportion of the pelvis.

Convalescence was stormy; but sepsis was combated by sulfanilamide therapy and the eventual recovery was complete.

The author desires to express his appreciation to Dr. James G. Townsend, Director of Health, Office of Indian Affairs, and to Dr. W. W. Peter, Medical Director, Navajo Service, for permission to publish this paper. Appreciation is also expressed to Dr. Nathaniel Safran, Junior Physician, Western Navajo Hospital, who assisted in the operation and gave valuable assistance in the care of the patient.

ANTENATAL VOLVULUS WITH STRANGULATION AND PERFORATION INVOLVING A PORTION OF THE ILEUM*

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A 20 year old primi gravida at term was admitted February 1, 1937 to the Methodist Episcopal Hospital of Brooklyn. She had had irregular labor pains of approximately sixteen hours' duration. Her clinic record covering the last trimesters showed a negative Kahn and Wassermann, normal blood pressure, negative vaginal smear for yeast and trichomonas vaginalis, and an occasional very faint trace of albumin in the urine. Her pelvic measurements were not remarkable except for a narrowed outlet of 7.5 cm.

After a thirty hour labor, during which nembutal gr. 7½ and codeine sulfate gr. 2 were given, the patient was delivered by one of us (D. A. J.) under gas-oxygen-ether anesthesia. The fetal heart was heard throughout labor. An episiotomy was done and small Simpson forceps were used to assist in delivery of the head, which presented in the ROA position. Moderate difficulty was then experienced in delivering the body. This was found due to a considerably distended abdomen presenting a thick leathery wall marked with a few scattered areas of ecchymosis. The child, a female weighing 7 pounds 2 ounces breathed irregularly and showed marked pallor and flaccidity, especially of the extremities. Its temperature was 96°F. and it lived only two hours despite injections of alpha lobelin and adrenalin, and frequent oxygen administrations. No bowel movements or vomiting were recorded during this period. Before death the clinical impressions included: polycystic kidneys, basilar hemorrhage, Hirschsprung's disease, intestinal stenosis, and abdominal trauma.

The post-mortem examination (E. B. Smith) revealed marked cyanosis of the head and extremities. The anus was open and protruding. The abdomen was markedly distended. About 200 c.c. of dark brown fecal-like fluid escaped when it was opened. A greatly dilated loop of ileum was lightly adherent to the under surface of the liver. The mesentery had undergone a complete turn in a *clockwise* direction with torsion and compression of the vessels at the root. Four loops of ileum lay parallel to each other, included in the volvulus. The three proximal loops were dilated, their walls edematous and thickened. The serosa was red and shiny, the vessels engorged. The distal loop adhered to the liver and was dilated to a diameter of 4 cm. Its walls were dark red with purplish areas, the serosa dull. A perforation at the right-hand end allowed intestinal contents to escape. The remainder of the ileum was 8 mm. in diameter and appeared normal. All other abdominal organs were normal in size, position, and development and showed no gross pathology.

Sections were made of one of the strangulated loops of ileum. The wall was thickened and there were small extravasations of blood here and there. The lumen contained blood. The tissue showed no evidence of necrosis.

The liver cells showed granular degeneration.

The diagnosis was: Volvulus neonatorum (ileum), accompanied by strangulation of ileum, spontaneous perforation of ileum and granular degeneration of the liver.

DISCUSSION

In explanation of the factors responsible for abnormal rotation, we must consider briefly the development of the gastrointestinal tract in the embryo. Fundamental work on the development of the intestine and its anatomic position was done by Mall[7] (1898). Frazer and Robbins[3] (1915) among others, also contributed much to the knowledge of intestinal rotation. More recently, since the very comprehensive report of Dott[2] (1923) a flood of articles on

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malrotation and its complications have appeared.[1,4,5,6,9–13]

The primitive alimentary canal develops

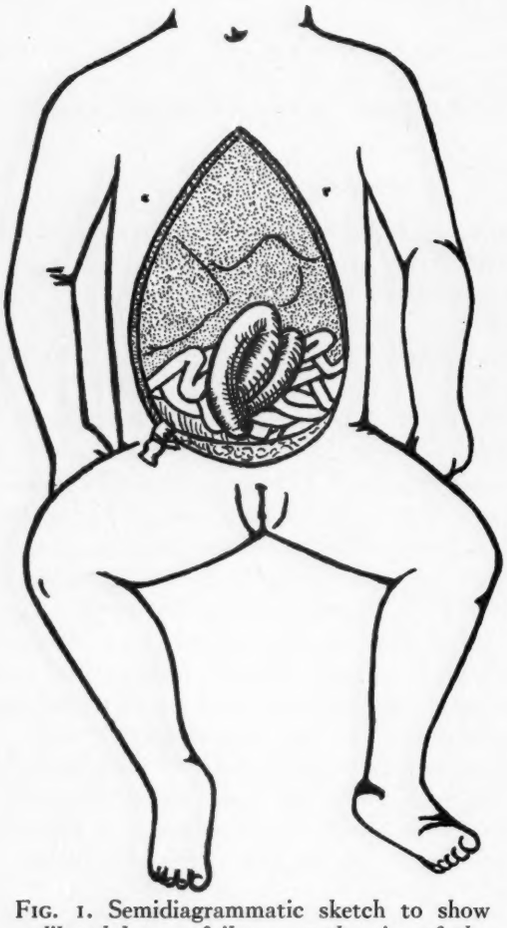

Fig. 1. Semidiagrammatic sketch to show dilated loops of ileum at the site of the volvulus.

from endoderm and is soon roughly divisible into three portions. However, the midgut, because of its mobility, is the chief site of abnormal rotation, and it is here that the present ileal volvulus occurred. The midgut stretches from the biliary papilla through the jejunum, ileum and the right end of the transverse colon. It is supplied by the superior mesenteric artery and flanked by the foregut (stomach and duodenum) above, and the hindgut (left end of the transverse and the whole of the descending colon) below.

Somewhere about the tenth or eleventh embryologic week this rapidly elongating midgut loop, which previously has been forced out into a sort of umbilical hernia by the growing liver, is returned to the abdominal cavity, and rotates (normally) *counterclockwise* 270 degrees about the axis of the artery. This places the duodenum behind, and the transverse colon in front of the mesenteric vessels. *The exact timing of the return of these viscera into the abdomen is held to determine their relative disposition.* It may be at this particular stage that the present volvulus occurred, i.e., four loops of the ileum were rotated (abnormally) *clockwise* 360 degrees. Moreover there was no apparent defect, consequent to malrotations, in the mesentery or its attachments, such as noted in the literature[2,4,13] which might account for this abnormality.

As a precipitating factor in infant volvulus one must discard in this case the theory of active persistalsis incident to the first food taken,[4] for this infant received no feedings before it died two hours after delivery. In addition it should be noted that the entire midgut did not join in the abnormal rotation, and thus this case differs from one type of malrotation that has been reported.[2,9] Finally, the strangulation and perforation present in the ileum afford interesting ground for speculation. From the pathologic evidence they appear to have developed long after the volvulus is supposed to have been formed.

Several questions, unanswerable at present, immediately arise: Is there some physiologic activity of the bowel only present shortly before birth? And did this precipitate the strangulation of the twisted loops with the sequence of perforation and death? Or is the thirty hour labor to be taken as the chief factor in the strangulation?

SUMMARY

1. A case of antenatal volvulus of the ileum with death two hours after birth is presented.

2. A brief survey is made of gastrointestinal development with some emphasis on the *normal* rotations of the primitive midgut, to bring out more clearly the *abnormalities* in rotation, of which this case furnishes an unusual example.

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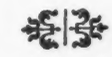

It can be fairly stated that bleeding from the bowel is the most important single symptom pointing to organic disease of the intestinal tract. . . . It is an indication of a break in the mucosa of the bowel somewhere along its course, or in the epithelium of the anal canal.
From—"The Rectum and Colon" by Hayden (Lea & Febiger).

SUCCESSFUL REMOVAL OF A GANGRENOUS APPENDIX IN A PREMATURE NEWBORN*

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THIS case is reported because the patient is younger than any recorded in the literature and because it serves to call attention to the incidence of acute appendicitis in irreducible scrotal hernia of the infant.

Baby S, a 6 day old negro male, was admitted to Freedmen's Hospital November 27, 1938 because of swelling of the scrotum and persistent vomiting. Two days previous the mother had first noted a swelling of the right scrotum, and the next day, the baby became fretful, cried almost constantly, vomited everything, and had no bowel movement. The swelling increased in size.

The infant had been delivered at home, November 21, a premature of 7½ months. The baby weighed only 4 pounds at birth but was apparently healthy and strong and had been taking breast feedings well.

On physical examination, it cried whenever handled, the lips were dry and tongue coated. Its weight was 3 pounds 1 ounce. The right side of the scrotum contained a mass 2½ cm. in diameter which was tense and apparently tender. The mass extended up to the external ring where it narrowed and disappeared in the lower half of the inguinal canal. It did not change in size during crying. The adjacent abdomen was normal. The right testicle could not be distinguished from the swelling, but the left testicle was of the expected size and in the dependent portion of the scrotum.

Temperature was 101 and pulse 120, respirations 28. The red blood cells numbered 6,350,000, the whites 8,450.

A diagnosis of strangulated right indirect inguinal hernia was made, the scrotum elevated, the baby sedated and placed in Trendelenburg position.

During the next six hours the baby had a bowel movement and vomiting ceased, but the mass did not reduce in spite of sleep. Conservative therapy was, therefore, abandoned. By the time an operative permit was obtained, another eight hours had passed and definite redness and local heat of the skin had developed.

Operation. Without anesthesia the conventional incision employed for inguinal hernia was made and extended down over the base of the scrotum. The cecum was found in its usual position inside the internal ring, but the appendix traversed the entire length of the inguinal canal into the scrotum. Distal to the external ring it was gangrenous and united in a purulent mass with a bilobed testis which was twice the diameter of the left testicle. There was free pus present and all structures including the skin were edematous and thickened. The appendix was amputated; the stump inverted, and the internal ring closed. Silk sutures were used throughout. The testicle was separated from the gangrenous portion of the appendix and replaced in the scrotum. The skin was sutured with a few silk sutures and the dependent portion of the scrotum drained with a small bit of rubber tissue. The baby left the operating table in good condition.

Postoperative Course. The temperature rose to 104 degrees on the day following operation and then dropped from day to day. No physical signs or symptoms of peritonitis developed. During the first three postoperative days the patient was given a clysis of 50 c.c. of normal saline in the buttocks twice daily. He was given two hour feedings and the usual treatment for prematurity. The feedings were well taken, but the baby did not begin to gain weight until a week after operation. The wound drained freely and developed redness of the skin edges. The rubber tissue was removed on the third day because adequate drainage was being established by separation of the edges from the midportion of the incision to its most distal extremity. The skin sutures were removed over

* From the Department of Surgery, Howard University, Washington, D. C. Read before the Academy of Surgery, Washington, D. C., February 10, 1939.

this entire area on the fourth day. Healing then became very sluggish, as is characteristic of the process in undernourished, partially dehydrated infants. Vitamin C was added to the diet in rather large quantities in the hope that it might stimulate repair. There was some apparent improvement. The wound completely healed eighteen days after operation. At this time the baby's weight was 3 pounds 14 ounces. When it was approximately three months old, it weighed 6 pounds. A definite hernia in the region of the scar was noted, but the right testicle was only slightly larger than the left.

COMMENT

The pathologic report confirmed the diagnosis of gangrenous appendicitis. The attempt to save the right testicle was of doubtful efficacy.

Appendicitis has been described at all ages. Mason and Hill[1] reported a case with death on the third day of life which apparently developed prenatally. Christowa[2] has also reported an inflamed appendix causing death from peritonitis in a three day old infant. Abt,[3] in 1917, collected from the literature eighty cases of appendicitis occurring in infants under three years of age. A generous percentage of these in males were in strangulated inguinal herniae. In the twenty cases under three months of age, sixteen were in males and eight were in strangulated herniae, an incidence of 50 per cent. There were four males in the group between three and six months but none were in herniae. Between six months and a year there were seven males and two had strangulated hernia or an incidence of 24 per cent in strangulated hernia in the males. The incidence is so high that the possibility of the appendix being involved in a right sided strangulated inguinal hernia in the male infant must always be considered. The development of the gangrene undoubtedly originates mechanically from an occlusion of the blood supply. The prognosis with treatment is invariably good. Of the fourteen cases cited by Abt all recovered. The youngest patient reported in the literature was 12 days old,[4] and the next youngest fourteen days, reported by Kramer.[5] Another of the same age was reported by Hoffman.[6] Bachy and Rabourdin[7] have recently called attention again to the occurrence of appendicitis in right sided herniae in males of all ages.

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NEW INSTRUMENTS

THE CAHAN NAIL EXTRACTOR*

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THE instrument is designed to extract nails placed in the neck of the femur for support in the open reduction of fractures. Its purpose is to accomplish this removal with a minimum of trauma to the surrounding bone and soft parts.

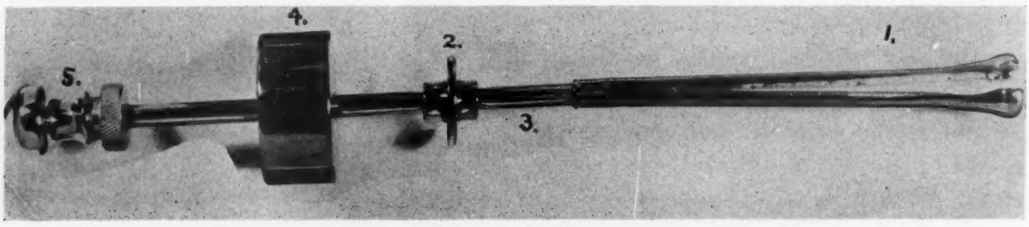

FIG. 1. The Cahan nail extractor.

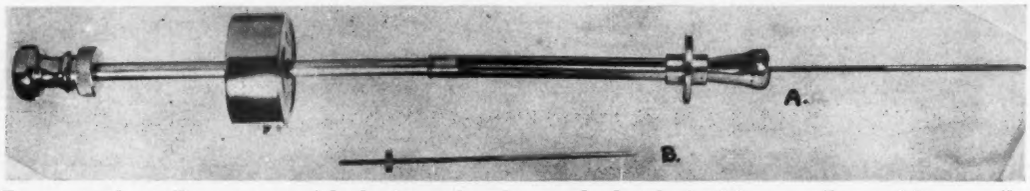

FIG. 2. A, the nail extractor with the jaws closed over the head of a Moore nail. B, a Moore nail.

The instrument is based on the principle of the carpenter's hammer, which drives a nail home by the application of force to the head of the nail; the extractor drives the nail out by the application of a similar force in the opposite direction.

The extraction is accomplished (Fig. 1) by the use of a pair of jaws, "1," clamped on to the nail head by means of a sliding sleeve, "2." This part of the instrument is continuous with a straight shaft, "3," upon which slides a cylindrical weight, "4." This functions as does the head of the carpenter's hammer. At the end of the shaft is a steel bolt, "5," which serves a double purpose: It acts as a handle for the instrument when it is in use, and as a backstop for the cylindrical weight when it is moved backward during the extraction maneuver.

When in use, the shaft of the instrument is placed in line with the axis of the nail, the jaws are placed over the head of the nail and the sleeve is slid forward as far as it will go, thereby locking the jaws over the nail head. (Fig. 2A.) Then with the handle between the thumb and first two fingers of the left hand, the cylindrical weight is moved forward with the right hand along the shaft up to the junction of the shaft and the jaws of the instrument; it is then moved back so as to deliver a sharp blow against the backstop. One to several such blows will usually suffice to extract the nail.

This instrument has been used by Dr. Nelson W. Cornell to extract Moore nails (Fig. 2B) in a small series of cases. In each instance the procedure has been accom-

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plished satisfactorily through a small skin incision. It is to be noted (1) that no leverage is used against the femur itself or any other part of the patient's body to secure countertraction for the instrument; (2) that the force of extraction is applied directly in line with the longitudinal axis of the nail, thus minimizing trauma to the bone in which the nail is embedded; and (3) that the nail is extracted as easily as it is hammered into place, for, in effect, it is hammered out in the same manner.

SUMMARY

1. An instrument is presented that is designed to extract nails from the neck of the femur, and is known as the "Cahan Nail Extractor."

2. In action, this extractor is analogous to the hammer which hammers the nail out of its bed.

3. The use of the instrument involves a minimum amount of adventitious trauma and a maximum of ease for the operator.

Correction: It has been brought to our attention that the name of the coauthor of an article by Dr. Kimpton in our August, 1940, issue should have read A. Reynolds Crane and not D. Reynolds Crane.

SPECIAL MONOGRAPH

The Surgery OF Mediastinal Tumors

BY

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AND

WILLIAM DEWITT ANDRUS, M.D.

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THE SURGERY OF MEDIASTINAL TUMORS*

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THE mediastinum harbors an extraordinary variety of benign and malignant tumors. A survey of our own experience and a review of the literature shows that these include the dermoid cysts and teratomas, the cysts of endodermal and mesodermal origin, the cystic lymphangiomas and the echinococcus cysts. The connective tissue tumors include fibromas, lipomas, leiomyomas, xanthomas, chondromas, chondromyxomas and chondrosarcomas. Neurogenic tumors include neurofibromas, ganglioneuromas, neuroblastomas and neuroepitheliomas, the benign and malignant tumors of the thymus gland; the primary tumors of the mediastinal lymph nodes include lymphosarcoma, Hodgkin's disease and endotheliomas, the primary and secondary sarcomas, the rather heterogenous group of primary and metastatic carcinomas and the intrathoracic goiters. The very number of the lesions precludes a full consideration of them, yet an effort will be made to cover their salient features. Before doing so, some general statements will be made regarding the symptomatology, diagnosis and treatment of mediastinal tumors which apply more or less to all of them.

Occasionally a mediastinal tumor may be asymptomatic and is discovered during the course of a routine physical examination. But when mediastinal tumors give rise to symptoms these may be of two kinds, general or local. By general symptoms we mean the common symptoms of pain in the chest, cough, dyspnea and cyanosis. They are the result of mediastinal compression, and vary with the size and location of the lesion and degree of compression of various mediastinal structures. The pain may be dull and aching, may be sharp like that in pleurisy or may be dull and boring as in aneurysm. It may be local and referred to the region of the tumor, or it may be referred a considerable distance. The cough usually is irritative, absent at times and again distressing. Irritation of the pleura or of a bronchus by pressure is usually the cause. It is frequently accompanied by a scanty mucoid expectoration, but may be associated

* From the Department of Surgery, New York Hospital and Cornell University Medical College.

with bloody sputum, at times with severe hemoptysis, with the expectoration of pus or of hair, tumor fragments or other material of value in diagnosis. Dyspnea is a variable symptom but at some stage of the disease manifests itself with great regularity. It is sometimes inconspicuous in large tumors but may be disturbing in small tumors. It may or may not be associated with cyanosis.

In addition to these general manifestations of mediastinal tumors are other signs which may be designated as local in the sense that they are visible through local swellings or are due to implications of structures in the immediate neighborhood of the lesion. Visible swelling over the chest or in the suprasternal region, in rare instances with pulsation, dilatation of the veins of the neck and front of the chest sometimes associated with edema of the face, inequality of the pupils or a definite Horner's syndrome, hoarseness due to pressure upon the recurrent laryngeal nerve, dysphagia due to pressure upon or dislocation of the esophagus, herpes or neuralgia due to pressure upon intercostal nerves, all are manifestations of mediastinal tumor observed with variable frequency, some of which at times have a definite localizing value. The occurrence of Horner's syndrome, for example, suggests not only a lesion of the posterior mediastinum but one involving the paravertebral sympathetic chain.

The symptoms just enumerated, it will be observed, are due largely to mechanical causes; and not infrequently death in mediastinal tumors is due to mediastinal compression and its effects upon the respiration and circulation. In malignant lesions, anemia, loss of weight and strength and irregular fever occur as in other malignant tumors but are seen less frequently, due, perhaps, to earlier death from compression symptoms. It should be recognized that tumors of the mediastinum may cause symptoms referable to the spinal cord; conversely, tumors arising within the spinal cord may extend into the mediastinum.

In the diagnosis and differential diagnosis of mediastinal tumors, all the resources of the internist, roentgenologist, bronchoscopist and surgeon may be necessary. Careful physical, roentgenographic, bronchoscopic and sputum examinations will serve in some cases not only to establish the presence and location of a lesion but also its pathologic nature. In other cases the application of these diagnostic methods succeeds in establishing the presence of a mediastinal tumor but fails to indicate its nature. In some of these, and especially those near the thoracic wall, an aspiration biopsy may

serve to establish the pathologic diagnosis, in others, the removal of an accessible involved gland, and in still others the response of a lesion to a controlled dose of roentgenotherapy. But experience shows that in not a few cases all our present diagnostic methods fail to establish the pathologic nature of the tumor, although they do establish its presence and its location within the mediastinum.

Confronted with this situation, the thoracic surgeon, in the diagnosis of certain mediastinal tumors, comes to rely upon his experience first, with respect to the kind of shadow in the roentgenogram cast by various mediastinal tumors and second, with respect to the predeliction of certain tumors for certain locations in the mediastinum. Neither of these criteria is infallible, but they not infrequently serve to differentiate between a benign tumor amenable to surgical removal and a malignant lesion which is inoperable. Certainly in our experience a clearly defined, circumscribed shadow in an *x*-ray film is most often cast by a benign tumor; although it does not rule out such lesions as ganglioneuromas or teratomas which have undergone malignant degeneration, certain sarcomas, or lesions other than tumor, as mediastinal abscess and non-pulsating aneurysms. Again, in our experience, the diffuse, poorly defined, irregular shadow is most often associated with malignant conditions, a finding to which also there may be exceptions. Less important than the *x*-ray is the diagnostic information obtained from the particular location of the lesion. Tumors in the posterior mediastinum are particularly apt to be the ganglioneuromas or other neurogenic neoplasms arising from the sympathetic chain or thoracic nerves, or the various forms of chondroma arising from the costovertebral articulation or intervertebral discs. The dermoid cysts almost always occur in the anterior mediastinum, and so on. Frequently, however, such distinctions have no meaning, for tumors, when they reach any considerable size, may defeat all efforts to determine their exact site of origin. It must be admitted, when all is said, that one of the handicaps to more intelligent treatment of mediastinal tumors lies in our diagnostic limitations.

The indications for treatment and the kind of therapy advisable for the various tumors of the mediastinum may here be touched upon in a general way, leaving fuller discussion of these matters to our later consideration of individual groups of tumors.

A question which appears to arise with increasing frequency is what our attitude should be toward the mediastinal tumor without

symptoms or with insignificant symptoms. There seems little doubt that various benign tumors may fail to provoke symptoms over long periods of time. The occasional finding in an aged individual of a tumor which, because of its nature, must have originated early in life, even suggests that a person may carry a tumor throughout life without serious impairment of health. There is evidence to show that some benign tumors undergo slow and continuous growth as might be expected; that others, having reached a certain size, become for a time quiescent or grow so slowly that their growth cannot, over a period of several years, be demonstrated in the *x*-ray film; that still others, after a period of quiescence, again may begin to grow, and that this secondary activity may indicate a malignant change in a previously benign tumor. As a general rule we think it can be said that tumors without symptoms or with insignificant symptoms may be expected to provoke symptoms sooner or later because of simple enlargement or malignant degeneration. Our own experience and a review of the literature suggests that the individual who continues to harbor a benign tumor is subject to definite danger. Among thirteen cases of dermoid cyst and teratoma in our own series, five had undergone malignant change at the time they came under our observation. In a review of 217 cases of dermoid cyst in the literature we find that forty-seven patients remained untreated and all died of the disease. Of twenty-eight cases of lipoma of the mediastinum, thirteen patients were not treated and all died; and in seven death was directly due to the lesion. In eighteen cases of fibroma of the mediastinum, thirteen patients were not treated and all died; in five the tumor was removed and all recovered. We could enlarge upon such data as these. The point we wish to make is that the lack of prominent symptoms in mediastinal tumor is to the individual a fortunate circumstance but does not necessarily imply that the lesion is quiescent, that it may not undergo malignant degeneration or that it may not eventually cause his death if not removed. It would seem wise seriously to consider surgery in this group of cases.

In the treatment of mediastinal tumors the question of surgical removal or roentgenotherapy naturally arises. From our own experience there would appear to be a tendency on the part of the profession to treat mediastinal tumors primarily by radiation. The opinion seems to be prevalent that *x*-ray therapy may achieve satisfactory results; and if it fails to do so, surgery then may be considered. We would suggest that this attitude be reversed; that upon the discovery

of a mediastinal tumor the surgeon, experienced in thoracic surgery, should be consulted; and not until he has concluded that surgery is inadvisable should *x*-ray therapy be undertaken. As we shall point out, certain benign tumors and some of the malignant tumors are amenable to surgical removal and in general these fail entirely to respond to *x*-ray therapy. Not only does *x*-ray fail to reduce their size but it may fail also to prevent their malignant degeneration. It may make subsequent attempts at surgical removal more difficult and hazardous because of the production of massive adhesions. It may be not only a wasted effort but one productive of harm to the patient.

A survey of our own cases shows that the dermoid cysts and teratomas, the various other mediastinal cysts, the intrathoracic goiters, the benign connective tissue tumors including those derived from cartilage, the benign tumors of neurogenic origin, the benign tumors of the thymus gland and certain primary but circumscribed sarcomas lend themselves to surgical removal; while the primary malignant tumors of the mediastinal lymph nodes (lymphosarcoma, Hodgkin's disease, etc.), the malignant thymomas and the various mediastinal carcinomas have proved unsatisfactory from the viewpoint of surgery. Such a rough grouping of cases at least indicates which of the various mediastinal tumors had best be treated primarily by surgery and which by *x*-ray therapy. The proportion of the total number of cases amenable to surgery as seen in a general hospital (New York Hospital) is suggested by our experience. In 145 cases of tumor of the mediastinum observed in the medical and surgical wards, 107 are examples of malignant disease and thirty-eight are examples of benign tumor. Of the 107 cases of malignant tumor, forty-seven are primary malignant tumors (lymphosarcoma, Hodgkin's disease) of the mediastinal lymph nodes, thirty-one are malignant tumors of the mediastinum secondary to cancer of the lung, twelve are malignant tumors secondary to other malignant conditions and seventeen are primary malignant tumors of the mediastinum. In this group of malignant lesions, surgery was contemplated only in the seventeen primary malignant tumors and of these surgical exploration was carried out in twelve. In six the tumor proved inoperable, in six the tumor was removed. Of the thirty-eight cases of proved or presumed benign tumor operation was performed in seventeen, in sixteen of which the tumor was removed. Of the twenty-one cases in which operation was not performed, sur-

gical opinion regarding operability was not requested in five; in five admission to the hospital was so late and symptoms so advanced that surgery could not be considered; in two symptoms were so slight that agreement regarding operation could not be obtained and in eight operation was refused. Of these twenty-one cases, six patients are known to be dead, eleven were followed for a time but cannot now be traced and presumably are dead and four are living and being followed. The total experience shows first that with earlier diagnosis a greater number of the primary malignant tumors may come within the field of surgery and second, that a larger percentage of the benign tumors should be subjected to surgery.

In addition to the tendency to delay in the surgical treatment of benign tumors as indicated by the twenty-one cases above noted, is the tendency to be deterred from seeking surgical relief because of the size of certain mediastinal tumors. The literature contains reports of patients with large tumors who have died from mediastinal compression symptoms and who, at autopsy, presented large tumors unattached to vital structures and easily removable. In general in these cases, the long duration of symptoms, the finding of a circumscribed shadow and the fact that the patients have, not long since, succumbed to the disease, suggests that the lesion was benign and did not involve essential structures within the mediastinum. We have removed tumors weighing as much as eight pounds with remarkably little effect upon the individual. The removal of such large tumors is a mechanical problem which may indeed present difficulties but these, with our present facilities, are not insurmountable.

OPERATIVE TECHNIC

Perhaps only three matters in the operative treatment of mediastinal tumors require comment. These are the choice and method of anesthesia, the surgical approach to the lesion and the closure of the thoracic wound.

Anesthesia. We have found that intratracheal anesthesia is the most satisfactory method in mediastinal tumors. The intratracheal tube may be introduced in the usual way under laryngoscopic observation or through the nose according to the method of Magill. As a method it has the advantage of relieving the surgeon of his fears of respiratory upsets when one or both pleural cavities are widely opened. If administered by skilled anesthetists, anesthesia generally is smooth and satisfactory. A variety of anesthetic agents

may be used with this method. Ether and oxygen alone is highly satisfactory and when in doubt, either with respect to the skill of the anesthetist or the condition of the patient, is perhaps the anesthetic of choice. Nitrous oxide-oxygen, combined if necessary with ether, has proved quite satisfactory with us. Better, however, in our experience, is cyclopropane gas with which a smooth anesthetic without a trace of cyanosis may be given even when both pleural cavities are opened.

Surgical Approach. The location and the size of the lesion determine the thoracic approach. Generally speaking, we have found that three surgical approaches will usually adequately expose the majority of mediastinal tumors. These are the anterior, lateral and posterior approaches.

Anterior Approach. This approach is applicable to tumors of small to medium size situated in the anterior mediastinum. An incision is made over the costal cartilage and rib most nearly corresponding to the midpoint of the tumor as shown in the *x*-ray film. The fibers of pectoral muscle are divided and a generous subperiosteal resection of the rib and costal cartilage to its sternal junction is made. If the tumor be small, an incision is made through the posterior periosteum of the resected rib, the pleura opened and exposure obtained with a proper rib spreader. If the tumor prove to be too large for delivery through the opening obtained, the approach can immediately be enlarged in the following way: A vertical incision is made along the right or left sternal border at right angles to the previous transverse incision. The costal cartilage above and below that previously resected is exposed and divided at its junction with the sternum. The rib spreader now produces a large triangular opening, its base at the sternal margin, and its apex at the lateral thoracic wall. (Fig. 1.)

Lateral Approach. This is applicable to the large mediastinal tumors which have extended laterally into one or other pleural cavity. A long incision encircling the hemithorax is made over the rib corresponding to the midpoint of the tumor. Such muscles as cover the rib are separated or divided. With the exposure of the rib the question arises whether to make an intercostal incision between it and the adjacent rib or to resect a long segment of the rib subperiosteally and open the pleura through its posterior periosteum. Either method may be used. After an experience with both methods we believe the approach to the pleural cavity through the posterior

periosteum of a resected rib to be more desirable because subsequent closure is more satisfactory. With the pleura opened a rib spreader is used to expose the wound as widely as may be necessary. In

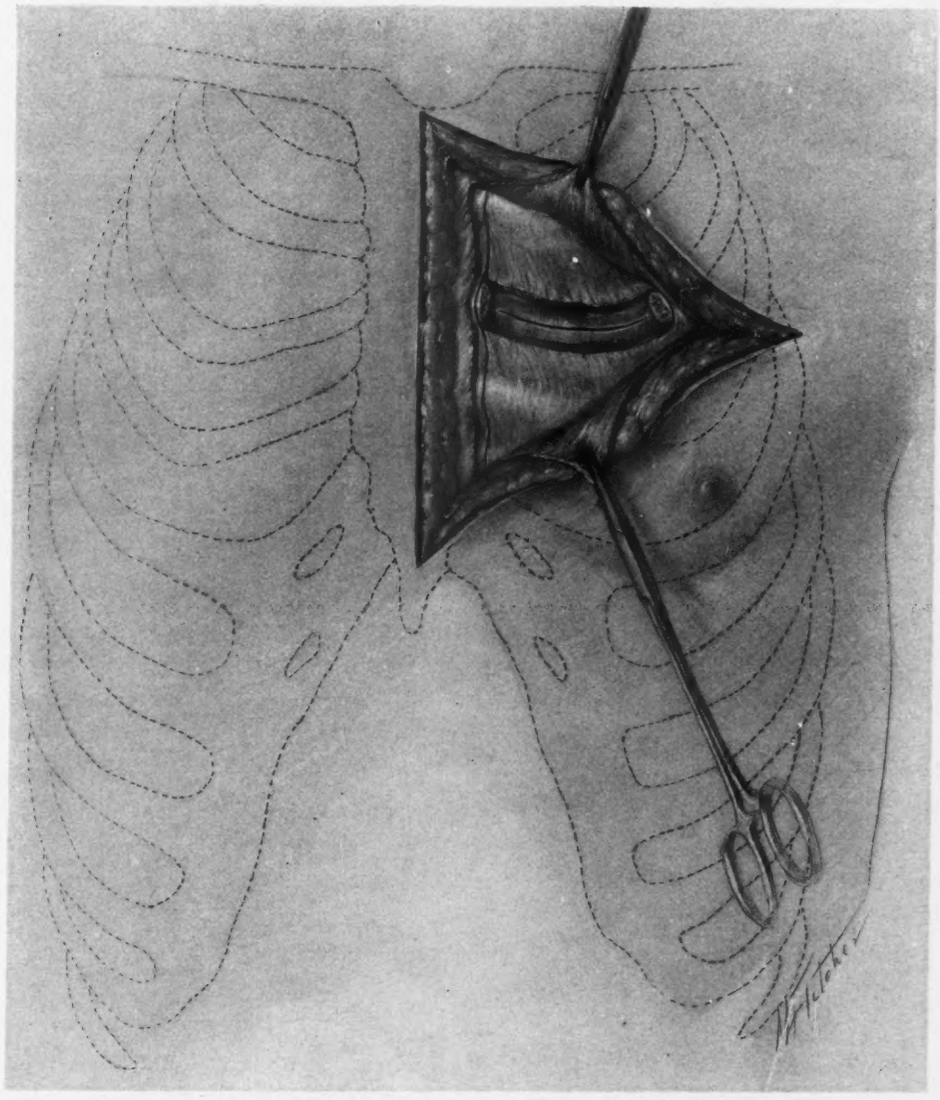

FIG. 1. Operative approach, anterior. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

cases with unusually large tumors in which the tumor cannot be delivered through the opening obtained, a rib or ribs above or below the rib resected may be divided at one or both ends of the incision making a trap-door type of approach. (Fig. 2.)

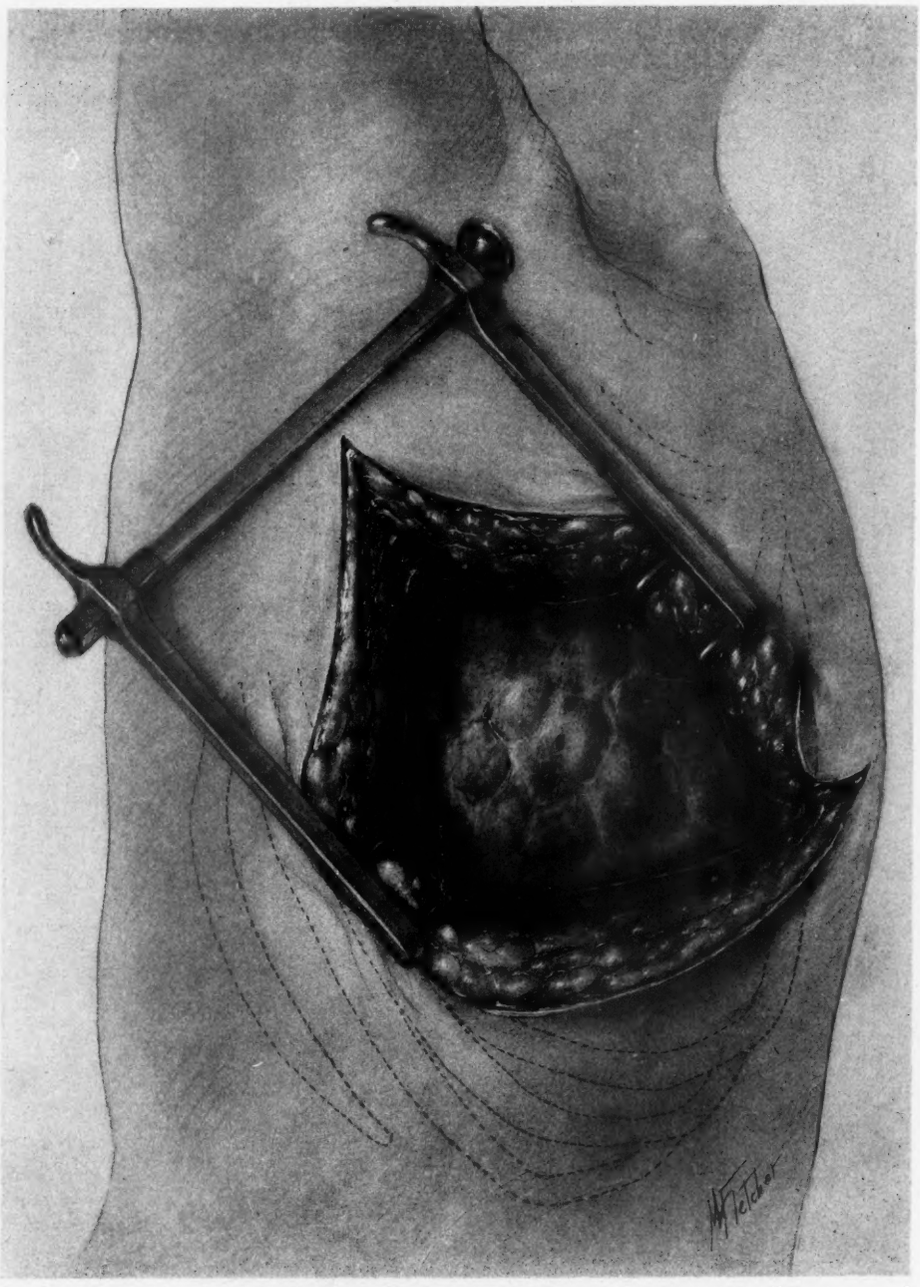

FIG. 2. Operative approach, lateral. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

Posterior Approach. This is satisfactory for the tumors which occupy the upper posterior mediastinum. An incision is made between the spine and scapula which, below the latter structure, is curved laterally so that the scapula may be retracted outward. The posterior muscles attaching the scapula to the spine are divided, the scapula is strongly retracted laterally and the underlying ribs exposed. Sufficiently long segments of the ribs overlying the tumor are resected subperiosteally and a flap consisting of intercostal muscles and the posterior periosteum of the resected ribs reflected in whatever direction seems best suited to the individual case. It is used in the subsequent closure of the wound. The pleura is opened widely and appropriate rib spreaders give an exposure sufficiently large for all but the really large tumors. (Fig. 3.)

Certain technics within the thorax which we have found useful may briefly be mentioned. A thin lappet of lung is attached not infrequently to a mediastinal tumor which at times cannot be separated without tearing into the lung substance. It is better under these circumstances to divide the strip of lung attached to the tumor and then suture the divided surface of the lung airtightly and with regard to total hemostasis. The freeing of a tumor down to its point of origin or attachment should be done with the greatest care not only to prevent hemorrhage, but to prevent injury to important mediastinal structures. Not infrequently it is found that after freeing a tumor to its point of origin or attachment the tumor itself so completely fills the operative field that its final removal cannot be achieved under direct vision. This is true particularly in tumors at the apex of the thoracic cavity. In cases of this sort, a Shenstone snare, such as is used in controlling the hilum in pulmonary lobectomy, may temporarily be placed about the tumor at its point of attachment and the tumor removed, after which, under direct vision, the remaining fragment of tumor can be excised and hemorrhage controlled.

Closure of the Wound. The importance of meticulous aseptic technic during the course of operation and of careful closure of the thoracic wound after operation within the thorax has been completed cannot be overemphasized. The reopening of the wound, whether this be the result of careless closure or of infection, is a most serious and may well be a fatal postoperative complication. An open sucking pneumothorax results, with its detrimental effects upon the respiration and circulation. Satisfactory reclosure is difficult and

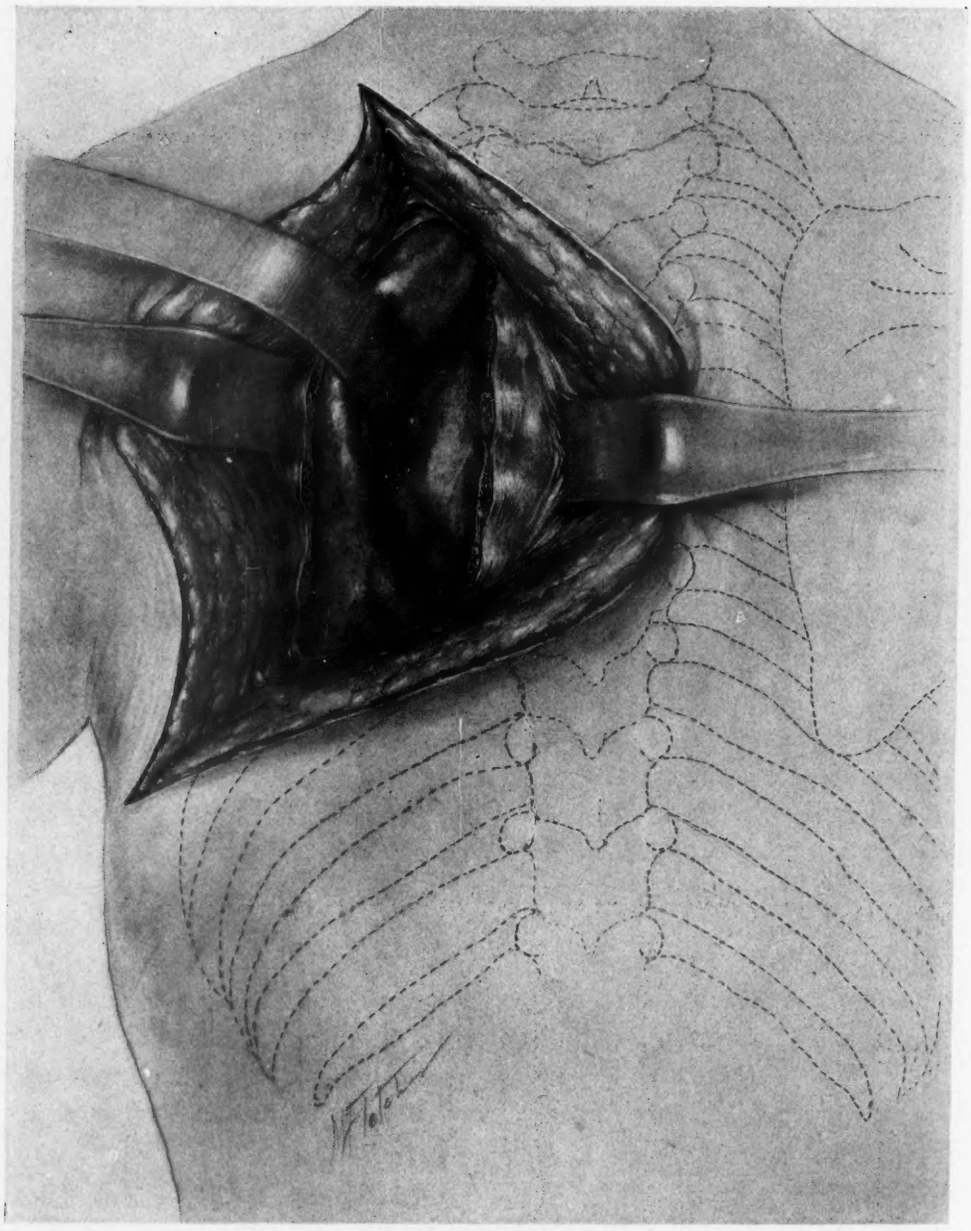

FIG. 3. Operative approach, posterior. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

oftentimes the problem presented is an unsurmountable one. Our own experience indicates that a careful closure of the wound in layers accurately approximated with interrupted sutures of silk is the best method. If ribs or costal cartilages are divided as is sometimes necessary in the anterior and lateral approaches, it is believed desirable to reapproximate the divided ends accurately with strong fine wire. The reason we prefer, in the lateral approach, the opening of the pleura by an incision through the posterior periosteum of a resected rib rather than by an intercostal incision is that the former offers better conditions for closure. If the incision has been made through the midline of the posterior periosteum, there is left on either side of it and attached to the intercostal muscles a strip of periosteum which holds firmly the silk sutures used in the airtight closure of the pleura.

The question of drainage of the pleural cavity arises when definite or suspected soiling has occurred in the course of the operation (dermoid cysts, etc.). Certainly drainage should not be used for bleeding at the end of the operation nor for anticipated pleural effusion which is common after operation within the thorax. These had best be treated by aspiration in the postoperative period. If, however, drainage is deemed necessary, it should never be established through the primary wound. To do so is to jeopardize the wound which may reopen with a resulting sucking pneumothorax. The best method we have found is to close the primary wound completely and establish airtight drainage of the pleural cavity at a distance from it by means of catheter introduced through a cannula.

There is little which needs to be said on the postoperative treatment. Supportive measures including blood transfusions may be necessary. An oxygen tent for the period immediately after operation is very desirable and is commonly used by us. The thorax is carefully watched by symptoms, physical examination and *x*-ray; and should a pleural effusion appear, the fluid is aspirated if it causes embarrassment. A pneumothorax, if not treated at the completion of the operation by aspiration and allowed to persist, tends to increase the liklihood of effusion and, therefore, had best be treated at the completion of the operation.

DERMOID CYSTS AND TERATOMAS

By far the commonest tumors of the mediastinum are the group designated as dermoids or teratomas. It is customary to include

under one or the other of these terms cysts or tumors of varying degrees of complexity, from the simple epidermoid cysts to those of more involved histologic composition. These tumors are congenital and probably have their origin from rests or misplacements of branchiogenic cells drawn into the thorax by the descent of the diaphragm and heart. Typically they arise in the anterior mediastinum and come to lie upon the anterior surface of the pericardium or in front of the great vessels, although they may assume other positions. In a number of the reported instances the tumor apparently arose from the thymus.

These tumors grow very slowly and usually remain quiescent for a number of years as indicated by the fact that only twelve, or 5.5 per cent of the 217 cases which we have collected were under twelve years of age. Symptoms appear rarely before puberty and the majority have not come under observation until the third decade. In some cases trauma or infection has been associated with an increase in the size of the tumor and the onset of symptoms.

In size these tumors vary from that of a walnut to that of a "man's head" or even larger. The largest reported tumors are those of Doran and Lester (30 × 40 × 20 cm. and weighing 5320 Gm.) and of Stanbury and Oille (31 × 18 × 16 cm., weighing 4173 Gm.). While they arise typically in the anterior mediastinum in front of the pericardium and great vessels, their location as disclosed by *x*-ray or at operation is variable. Duval classifies them as (a) retrosternal—not extending beyond the confines of the mediastinum, (b) cervico-retrosternal—presenting at the base of the neck, (c) mediastino-thoracic—extending into either thoracic cavity, and (d) lateral thoracic—lying largely in either thoracic cavity. The larger number of cysts causing symptoms are of the lateral thoracic variety.

The structure of dermoid cysts and teratomas varies greatly, the simplest being thin-walled cysts containing cloudy fluid or grumous material. Others contain ectodermal derivatives including skin, hair, teeth, etc., and the more complicated comprise tissues originating in all three germinal layers. Occasionally, a part of the cyst wall may undergo calcification and in a few cases the calcium deposits may be extensive. The solid teratomas are less frequently seen than the more simple cysts, and many of the former also contain cystic areas. A number of these tumors have been carefully studied and almost every variety of tissue found, while in others one tissue may overgrow the remainder, making the ultimate diagnosis difficult.

The most common complication of such tumors is infection resulting either from rupture of the cyst into a bronchus or from a respiratory infection. Such a complication may cause a sudden and rapid increase in the size of the tumor, provoking severe symptoms. The wall of the cyst becomes thickened and adherent to the surrounding structures while its contents may assume a thick, purulent character. Malignant degeneration either of a sarcomatous or carcinomatous nature may take place, but this is of relatively rare occurrence.

SYMPTOMATOLOGY

While a number of dermoid cysts and teratomas have been discovered accidentally or at postmortem in infants or young children, symptoms are rarely produced before the age of puberty. This latent period may extend far beyond adolescence, symptoms appearing only late in life. Indeed, in some cases the tumor remains completely asymptomatic and is discovered accidentally when the patient has reached an advanced age. The larger number, however, begin to produce symptoms when the patient is between 20 and 40 years of age, and so often after a respiratory infection that this may be considered to have initiated them. In others the symptoms of the tumor may be overshadowed by those of a coexisting pulmonary condition such as tuberculosis.

Pain, cough and dyspnea are the most common symptoms noted, and more rarely secondary symptoms from pressure on various mediastinal structures. In the occasional case in which cough is associated with expectoration of hair or other portions of the cyst's contents the diagnosis is evident. The physical signs are those to be expected from a mediastinal mass, and may in addition indicate certain of the effects of the tumor such as bronchial or mediastinal compression. If the cyst be infected, all these signs may, of course, be exaggerated.

The roentgenographic examination is of the greatest value in diagnosis and a spherical non-pulsating shadow in the anterior or superior mediastinum, or as more commonly seen, extending out into the lung field from this region, when taken with the clinical features often seen, makes the diagnosis almost certain. If bone or teeth are present in the cyst, they may be visible in the *x*-ray. When all other measures fail, aspiration of the tumor itself may be indicated and,

except when definite infection is present, would seem to be a relatively safe procedure. Even in the presence of infection it may not be contraindicated, provided the aspiration can be carried out through an area over which the pleurae are adherent. This procedure may yield brownish fluid containing epithelial cells from the simple cysts, grumous material or bits of hair from histologically more involved tumors.

When aspiration seems inadvisable or when the diagnosis is uncertain, exploratory operation may be required. This can be carried out easily and simple exploration should not be accompanied by any mortality in experienced hands.

Before considering treatment, however, a word should be said concerning the prognosis without operation. Such tumors have been discovered at autopsy or on routine physical examination without ever having caused symptoms, and in other cases have given rise to symptoms only late in life; in other words, the existence of intrathoracic dermoids or teratomas is not inconsistent with reasonable life for many years (forty-four years in one case). The advisability of surgery may, therefore, seem debatable in the asymptomatic cases; but these tumors, if untreated, give rise to symptoms so frequently, and complications such as rupture into a bronchus with infection of the cyst so often occur and add to the hazard and difficulty of surgery, that it seems wise to advise the extirpation of the cyst in all with the possible exception of the asymptomatic cases which can be examined at frequent intervals. Even in such cases, however, it is impossible to predict when complications such as rupture into a bronchus may occur.

The ideal procedure is complete extirpation of the cyst as this has given the highest percentage of cures and has been associated with the lowest mortality. Previous surveys of the results of surgical treatment are to be found in the paper of Aurousseau (Rev. de Chir. 62: 553, 635, 1924) and in our article in Lewis' Practice of Surgery (Vol. V, Chapter 5, p. 81). Since the latter was written, we have been able to collect seventy-five additional cases from the literature which, with seven recent cases of our own, bring the total to be considered here to 217 cases. Of these, thirty-two were discovered at autopsy, forty-seven patients died untreated, and in eight the treatment and results are unknown. The remaining 130 were subjected to operations of various sorts, the nature and results of which were as follows:

One patient, a child, was subjected to drainage of an empyema following what appears to have been a rupture of the cyst into the pleura and died during the operation. In two patients the cyst was exposed and was aspirated, with death in one case and failure to cure in the other. In five instances the cyst was found to be inoperable, three of which were due to malignant change. One patient died thirteen days after exploration, and while the remainder recovered from the operation, they succumbed to the disease. Simple drainage or marsupialization of the cyst was carried out in thirty-four cases with nine deaths. The remaining twenty-five patients recovered but only five were cured. Partial resection of the tumor was performed in twelve instances with two deaths and ten recoveries. Five patients were cured. Total excision has been the most widely employed procedure and has been followed by the lowest mortality and the highest percentage of cures. Thus in seventy-six cases, in which the tumor was completely removed there were but eight deaths, a mortality of 10.7 per cent, and all the remaining sixty-eight patients (89.3 per cent) were cured. This is to be contrasted with a mortality of 26.5 per cent and only 15 per cent cures in simple drainage of the cyst, and with the 16.6 per cent mortality and 41 per cent cures when the cyst was partially resected.

CASE REPORTS

E. S., (19993) N. Y. H. The patient was a 56 year old woman who first was admitted to the New York Hospital on November 15, 1920, at which time an adenoma of the thyroid was removed. Recovery was uneventful and the pathologic report indicated that the adenoma removed was in no way unusual.

On January 18, 1933, she was admitted complaining of extreme dyspnea and non-productive cough but no pain. Examination showed marked dyspnea on slight exertion, the chest dull to percussion on the right with bronchial breath sounds and a few rales. A roentgenogram of the chest showed displacement of the trachea to the left and a large, well-outlined tumor in the right upper lung.

On January 22, 1933, under local anesthesia, a thoracoplasty and exploration of the chest was performed and a tumor the size of a grapefruit was found. During manipulation the capsule of the cystic tumor was ruptured with the escape of a large quantity of chocolate-colored fluid. Because of the patient's condition, the removal was not attempted; the wound was packed with saline after the mass had been completely walled off from the pleural cavity. After a week the packs were removed and drainage

established. The marsupialized tumor mass sloughed out slowly and 2 months after operation only a very small piece of it remained which soon came away. From this time on the wound healed in and the patient regained her strength. Repeated roentgenograms showed only scarring and fibrosis in the region the tumor had occupied. Nine months after operation no signs of the tumor remained and the patient was without symptoms.

E. B., (97699) N. Y. H. This patient was an 11 year old colored girl who was admitted to the hospital for further study of a chest tumor which had been discovered during the course of a routine roentgenographic examination. She was without complaint of any nature.

Physical examination on admission was negative save for a circular area of flatness in the anterior chest extending from the sternum to about the midclavicular line. The heart was displaced slightly to the left. Roentgenographic examination revealed a shadow of smooth outline blending with that of the right side of the heart and extending out into the right pulmonary field. Oblique and lateral films showed this to be distinct from the heart shadow, however, and it was thought to arise from the chest wall.

One week after admission the tumor was removed through an incision along the right border of the sternum with the resection of one rib. The tumor lay in the anterior mediastinum, was attached to the pleura and to the pericardium and seemed to have its origin in a persistent thymus. It contained about 100 c.c. of thick, brownish fluid and microscopic examination of the cyst wall showed it to be a relatively simple teratoma.

Convalescence was uneventful save for a pleural effusion which disappeared within three weeks of operation. Three months later the patient was in good health and able to return to school. (Figs. 4 and 5.)

CYSTIC LYMPHANGIOMAS

Cystic lymphangiomas are occasionally found in the mediastinum, usually near the hilum or in connection with the pericardium. Some have attained great size. Excision was attempted by Michaelis but proved to be impossible and the patient died.

CILIATED EPITHELIAL CYSTS

Through the defects in the process of development of the esophagus and lower respiratory tract a series of anomalies may occur resulting in the production of cystic tumors. Thus, a bit of undifferentiated tissue may be pinched off in the process of separation of the esophagus from the trachea, and undergoing later growth, give rise to a cyst lined with ciliated epithelium along the course of the esophagus, particularly in its lower portion. The development

FIG. 4. N. Y. H. 19993, E. S. Dermoid cyst. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

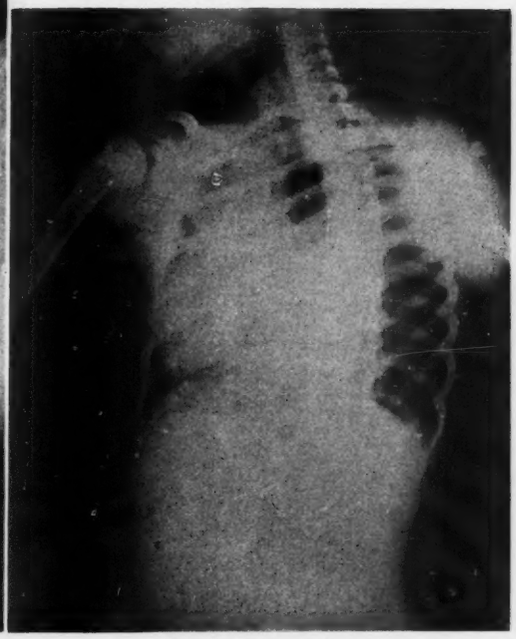

FIG. 5. N. Y. H. 97699, E. B. Teratoma.

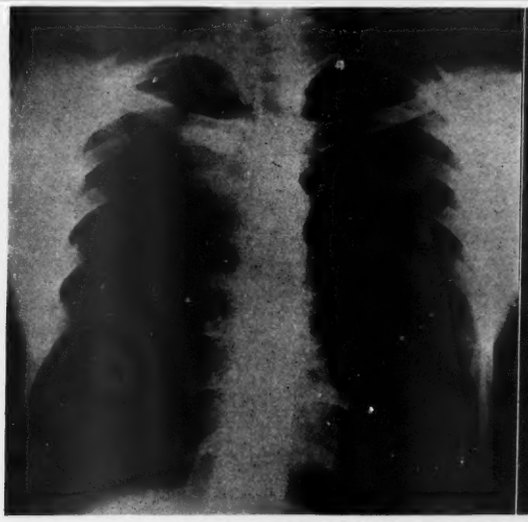

FIG. 6. N. Y. H. 236674, P. K. Ciliated epithelial cyst, anteroposterior view.

FIG. 7. N. Y. H. 236674, P. K. Ciliated epithelial cyst, lateral view.

of the bronchi through a number of dichotomous divisions of the primitive trachea is a complicated process and, depending on the stage at which an aberrancy occurs, tracheal diverticulae, tracheal accessory lung, cysts of the respiratory epithelium in the mediastinum, accessory lobes of the lung or intrapulmonary cysts may arise. We are concerned here only with the third type of anomaly.

Cysts of respiratory epithelium in the mediastinum are located near the major bronchi, and while this is not always the case, tend to occur predominantly on the right side. Usually they present as rounded, thin-walled tumors projecting between the trachea and the vena cava or in this immediate neighborhood. Stilling has reported such a cyst of considerable size in the anterior mediastinum, and when in this location a derivation from the thymus is to be suspected.

The lining cells of the cysts are columnar or flattened and bear cilia. The remainder of the wall is derived from the mesenchyme and may contain fibrous tissue, cartilage, muscle or mucous glands. The contents consist of mucoid material containing desquammated cells and débris. No connection with the bronchi is demonstrable.

The number of intrathoracic cysts to be included in this category depends upon whether the group is confined to those contained in the mediastinum or is expanded to take in others located more laterally and arising within the lungs themselves. We have found in the literature twenty-five cases arising in the mediastinum and have encountered one ourselves. Many of the tumors were discovered at autopsy, and in only twelve instances was operation directed at the removal of the cyst. As this would indicate, many of these cysts fail to give rise to symptoms, but in others due to their origin close to the great vessels, symptoms from pressure on these structures or on the esophagus or air passages may be produced. Certain of the cysts have become infected and have caused serious or even fatal symptoms. Occasionally, as in our case, the *x*-ray picture of which is shown in Figure 6, the lesion was found when a chest film was taken in an attempt to explain why symptoms of a respiratory infection had not subsided after several weeks.

Differentiation from the more common dermoid cysts is not possible before operation, but is sometimes suggested when the *x*-ray shows a rounded mass presenting just above the hilum and particularly when lateral films show it to be located just anterior to the trachea.

While some of these cysts cause no symptoms, the tendency of many to increase in size and to compress the surrounding mediastinal and pulmonary structures, and the fact that some ultimately become infected with serious consequences, make operation advisable. In the twenty-five cases considered here, operation was undertaken in twelve, in eight of which the tumor was removed. In five of these patients the cyst was excised at the first operation and in three its removal followed preliminary drainage or marsupialization. Operation in the remaining four patients consisted either of drainage of the cyst or its partial removal. All the patients in whom complete removal of the cyst was possible recovered, one of them with a persistent bronchial fistula.

P. K., (236674) N. Y. H. The patient was a young man, aged 24 years, admitted to the New York Hospital June 6, 1939, complaining of stabbing pain in the chest over a period of three years. During the last three months these have occurred more frequently and have lasted longer. He had no dyspnea or cough. He had lost eighteen pounds in weight in three years.

Nothing noteworthy was found on physical examination except a slight bulging of the right dorsal chest, a scoliosis, limited excursion of the right diaphragm, slight dulness to percussion posteriorly and diminished breath sounds. Fluoroscopic examination showed a smooth, rounded mass to the right in the anterior mediastinum.

At operation on June 14, 1939, a mediastinal cyst was removed.

Recovery from operation was satisfactory and the patient left the hospital on the seventeenth postoperative day with the wound completely healed.

The pathologic report of the tumor was: cyst originating in a branchial rest. (Figs. 6, 7 and 8.)

ECHINOCOCCIC CYSTS

Echinococcic cysts occur in the mediastinum but would appear to be very rare. In the chest the disease most commonly occurs in the lung and occasionally in the pleural cavity. Rose's case, cited by Christian, is an example of echinococcic disease of the mediastinum. The patient, a woman aged 25 years, had a small lump just above her right breast for six years. When seen the mass measured three inches in diameter, was hemispherical, tense, elastic and fluctuating. It lay over the sternal ends of the second and third ribs beneath the pectoral muscle. At operation the external mass proved to be a cyst which communicated by an extension through the thoracic wall with a much larger cyst in the anterior mediastinum. From the latter

cyst both scolices and daughter cysts were obtained, confirming the diagnosis. The patient recovered and the wound healed. The case is an example of hour-glass cyst of the anterior mediastinum. Similar to it are the seven hour-glass echinococcic cysts of the posterior mediastinum described under hour-glass tumors of the spine. (Fig. 9.)

MEDIASTINAL FIBROMAS

So far as we can discover, thirty-two cases of this form of mediastinal tumor have been observed. The diagnosis of pure fibroma in all cases is not altogether clear, for the description of the lesions suggests in some instances invasive qualities as if they might be fibrosarcoma. In size they have varied from small tumors to lesions as large as a child's head and more often have occurred in the anterior mediastinum. In at least three cases, however, the tumors were located in the posterior mediastinum. Garré reported a case in which there were two tumors, one in the anterior mediastinum, the other and larger in the posterior mediastinum. The point of origin or attachment is not often accurately described but apparently they may arise from the pericardium, vertebrae and mediastinal surface of the sternum. In one case the tumor apparently was attached to the arch of the aorta. The most carefully described tumors are hard, firm growths on gross and microscopic section presenting the appearance of fibromas.

Symptoms in this group of cases have in the majority appeared rather late and after the age of forty years. Their duration has varied from a few months to five or more years. Pain in the chest, cough, with or without expectoration, and dyspnea have been the common symptoms. Hoarseness, enlargement of the anterior thoracic veins, difficulty in swallowing and pain and swelling of the arm have been noted. The physical signs also have been those common to mediastinal tumors. In two cases symptoms and signs were those of pulmonary tuberculosis, one of the patients spending two years in a tuberculosis sanatorium before a diagnosis of tumor was made.

The diagnosis of mediastinal tumor should not be difficult, for these tumors cast a well-defined shadow in the *x*-ray film. That the tumor is a fibroma may well be impossible to establish. The diagnosis usually has been made only by operation or at necropsy.

From the available data the prognosis is good if surgery is undertaken, hopeless if patients with fibroma are left untreated. In our earlier collected series of eighteen cases, thirteen patients were not

FIG. 8. N Y. H. 236674, P. K. Ciliated epithelial cyst.

FIG. 9. V. C. Echincocccic cyst.

FIG. 10. N. Y. H. 225066, A. C. Myxoma, anteroposterior view.

FIG. 11. N. Y. H. 225066, A. C. Myxoma, lateral view.

subjected to surgery and all died of the disease; five were subjected to operation with removal of the tumor and all recovered. In fourteen cases which have appeared in the literature since that time, nine patients were subjected to operation with removal of the tumor with eight recoveries and one death; while in five the tumor was found at autopsy. Of the entire series of thirty-two cases, therefore, fourteen patients were subjected to surgery with thirteen recoveries and one death; eighteen were not operated upon and all died.

FIBROLEIOMYOMAS AND MYXOMAS

In connection with the fibromas may be mentioned various modifications of this type of tumor which have occurred in our series and have been described in the literature under the terms of fibroleiomyoma, fibromyxoma and myxoma.

Jacobeus and Einar Key have described two cases of fibroleiomyoma of the posterior mediastinum. They occurred in patients 23 and 28 years of age who complained of pain in the chest, cough and shortness of breath. The *x*-ray in both cases showed a spherical circumscribed shadow in the posterior mediastinum. In both cases the tumor was successfully removed. In one the tumor was attached posteriorly to the periosteum of the fifth and sixth ribs, in the other to the vertebrae and ribs. Pathologically, the tumors are described as an edematous fibroleioma with shreds of smooth muscle running through it.

Evarts Graham describes a myxoma of the anterior mediastinum arising from the mediastinal pleura. An interesting feature of the case was the occurrence of an external, visible and palpable mass 4×4 cm. in size in the region of the right nipple. The *x*-ray of the chest showed in the midsection of the right lung field a large, dense, spherical shadow chiefly without and anterior to the thoracic wall. Exposure of the area at operation showed the tumor growing between the ribs. After resection of the two ribs it was found that the tumor was encapsulated and extended some distance beneath the sternum. The tumor was successfully removed. The pathologic diagnosis was myxoma of the pleura.

A huge myxoma arising in the posterior mediastinum and occupying almost the entire anterior hemithorax was successfuly removed over a year ago by one of us (G. J. H.).

A. C., (225066) N. Y. H. This patient, a woman aged 41 years, entered the hospital complaining of fatigue, dyspnea and orthopnea of over six

months' duration, and of pain in the chest of six weeks' duration. She showed marked pigmentation of the face and body in the form of freckles and skin tumors of the fibroma molluscum type, warranting the diagnosis, in our opinion, of von Recklinghausen's disease. On examination she was obviously dyspneic and showed distention of the veins of the neck and upper thorax more marked on the right than left. The right thorax was flat on percussion from the second rib downward and posteriorly from the upper third of the scapula to the diaphragm. Breath sounds and voice sounds were absent over the area. The anteroposterior *x*-ray of the chest showed that the right half, with the exception of a narrow clear zone at the apex, was completely occupied by a dense circumscribed shadow. The lateral *x*-rays showed that the shadow occupied more than the posterior two-thirds of the right upper thorax. The exact nature of the tumor was not established but in view of the findings of von Recklinghausen's disease, a myxomatous type of tumor was suggested.

Operation was performed March 16, 1939. A lateral approach under intratracheal ether was made at the level of the sixth rib. On opening the pleura a firmly elastic tumor covered by a grayish white, opaque capsule was exposed. It was so huge that it was obvious the tumor could not be removed through the wound; this was immediately enlarged by dividing transversely and close to the transverse processes posteriorly the fifth, sixth, seventh and eighth ribs. Even with this large exposure it seemed impossible to free and deliver the tumor. An incision, therefore, was made through the capsule and there appeared a reddish, gelatinous tissue which could readily be stripped from the overlying capsule. Proceeding in this manner an enormous lobulated tumor mass eventually was cleanly delivered. It measured 34 × 29 × 10 cm. in diameter and weighed 3745 Gm. The capsule was then removed and found to be attached to the posterior mediastinum. The tumor grossly resembled the gelatinous, myxomatous tissue seen in the large external tumors of von Recklinghausen's disease (pachydermatoceles). The microscopic diagnosis was myxoma. The patient developed a mild intrapleural infection postoperatively which delayed her convalescence. She is perfectly well eighteen months after operation. (Figs. 10 and 11.)

XANTHOMA AND XANTHOSARCOMA

In a paper read before the American Surgical Association in 1923, one of us (G. J. H.) reported the successful removal of a xanthoma of the posterior mediastinum. At that time the only other case of intrathoracic xanthoma which could be found in the literature was the case of Wesson reported in the Acta Chirurgica Scandinavica, Stockholm, 53, 1921. Since then we have been able to collect eight

additional cases. It appears then that only ten cases of this tumor have been reported as occurring within the thorax.

In all cases reported these tumors have been observed in individuals between twenty-one and fifty years of age. The symptoms have varied but usually they have been the usual ones of pain in the chest, cough and dyspnea. Our case was unusual in that the patient, a physician, had no symptoms referable to his chest but had for fourteen years periodic, cramp-like pains in his right lower quadrant but without fever or nausea. His appendix had been removed without bringing relief. He was repeatedly examined without finding an explanation for his symptoms. During an attack of upper respiratory infection a routine *x*-ray plate of his chest showed a circumscribed spherical mass to the right of the cardiac shadow which a lateral plate showed to be in the posterior mediastinum. The removal of the tumor presented no difficulties and the patient has been well for many years. Pathologically, the tumor in gross section showed areas of yellow pigmentation like xanthomas elsewhere; microscopically, it showed xanthoma cells and groups of "foam" cells. (K., J. H. H. case.) (Figs. 12 and 13.)

The diagnosis of a circumscribed tumor in these cases can be made but the nature of the tumor has not, thus far, been established before operation.

All ten patients were subjected to surgery and the tumors successfully removed. There were no postoperative fatalities.

CHONDROMAS, ENCHONDROMAS, CHONDROMYXOMAS AND CHONDROMYXOSARCOMAS

These tumors have been reported under a variety of names as indicated. They have their origin in cartilage and may arise from the costal cartilage, sternum, costovertebral articulations and articular surfaces of intervertebral discs of the spine. In their growth they encroach upon the mediastinal space and compress its structures, and when large, may extend out into either thoracic cavity. Pathologically, they comprise two kinds of tumors: those which are solid and made up of cartilage (chondromas) and those (chondromyxomas) which are partly solid and partly cystic, the cystic portion consisting of ropy, sticky, clear or opalescent fluid or gelatinous myxomatous material. They present the characteristic of similar chondromas elsewhere, i.e., the tendency to recur or metastasize even though microscopically they are benign tumors. The determination of their

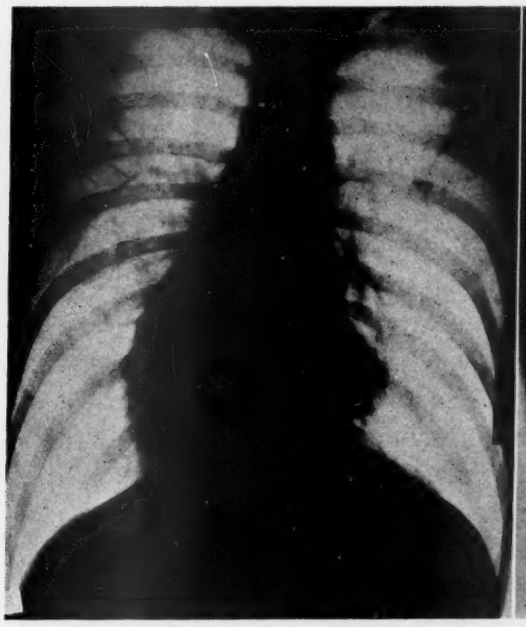

FIG. 12. K. Xanthoma, anteroposterior view. (From *Ann. Surg.*, 79: 670, 1924.)

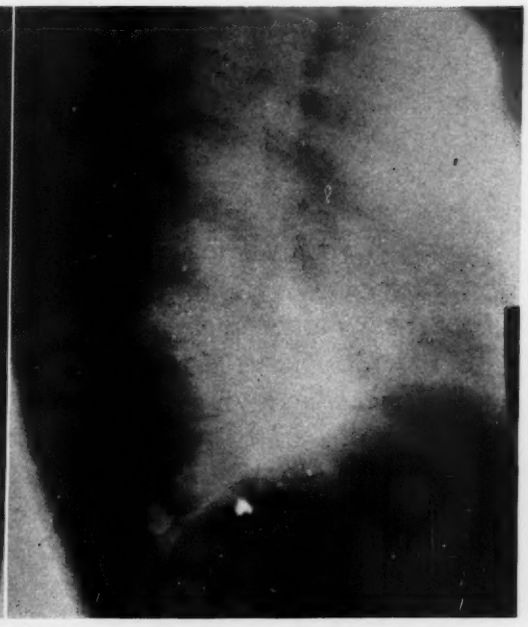

FIG. 13. K. Xanthoma, lateral view. (From *Ann. Surg.*, 79: 670, 1924.)

FIG. 14. N. Y. H. 24299, F. J. Echondroma.

FIG. 15. N. Y. H. 24299, F. J. Enchondroma.

benignancy or malignancy, therefore, is not always possible from a pathologic study of the material. From the viewpoint of surgery they have these characteristics in common: that they are circumscribed, encapsulated tumors, which in their growth crowd the mediastinal structures to one side, do not as a rule invade them and rarely become firmly adherent to them. They lend themselves, therefore, to surgical removal and this should be comparatively simple if the tumor has not attained large size.

The chondromas involving the mediastinum are rather rare tumors. In our experience we have observed four, a chondromyxoma of the mediastinum arising from the costovertebral articulation, a chondroma of the spine with compression of the spinal cord, a chondroma of the sternum and a chondroma of the costal cartilages, both of which occupied the anterior mediastinum. Evarts Graham reports a case of chondroma of the vertebrae encroaching upon the posterior mediastinum which later was removed by George Muller of Philadelphia. In the literature on tumors of the sternum there are, with the exception of our case, but two or possibly three chondromas. In the literature of the so-called hour-glass tumors of the spine five are chondromas (one called chondrosarcoma) arising from the articular surfaces of the vertebrae, intervertebral discs or heads of the ribs. In the literature since 1926 we have found but fourteen cases implicating the mediastinum.

The tumors may grow to great size. Three of the four cases we have observed have been tumors as large or larger than a grapefruit. They may produce a deformity of the spine as gibbus, a visible swelling of the sternum or bulging of the chest wall. Symptoms usually have appeared in adult life. Pain is usually the first symptom and may be present for long periods of time before other symptoms appear. It may be localized behind the sternum, in the chest or in the back depending upon the location of the lesion. It may radiate in the course of the intercostal or other nerves. Cough and dyspnea may appear later and increase in severity as the tumor grows. A local or diffuse swelling of the sternum or thorax, or a deformity of the spine may develop. In a case of Garré a gibbus, pain and paresis of the legs, led to a diagnosis of tuberculous spondylitis. In a case of our own, pain in the right upper thorax, attacks of fever, cough and bloody expectoration led to the diagnosis of pulmonary tuberculosis and the patient spent six months in a sanatorium before an *x*-ray established the diagnosis of tumor. In two cases in Schlaepfer's series in which

the tumors had extended into the vertebral canal, paralysis of the extremities, as in spinal cord tumor was a prominent symptom. This was also true of the most recent case of chondroma we have had under observation. With the enlargement of the masses all the symptoms common to mediastinal compression may appear, i.e., suffusion or cyanosis of the face, dilatation of the vessels of the neck and upper thorax, hoarseness, difficulty in swallowing and edema of the extremities.

The physical examination need not be detailed for the findings resemble those in other mediastinal tumors. *X*-rays show a circumscribed, well-defined tumor shadow. A positive diagnosis of chondroma is, of course, difficult to make but is suggested in anterior tumors connected with the sternum and costal cartilages and in some of the tumors of the posterior mediastinum.

These tumors lend themselves to surgical removal and would appear to fail to respond to *x*-ray therapy. As we have noted, the tumors are circumscribed and can in our limited experience readily be freed from surrounding structures and removed. In all four cases observed by us the tumor was removed without great difficulty. Three patients recovered; one patient died shortly after operation with the symptoms of pulmonary embolism. Of the three patients who recovered, one developed metastases a year after operation from which she eventually died. The tumor in this case was diagnosed as a benign chondromyxoma. Of the fourteen cases found in the literature more recently, seven patients were subjected to operation with the removal of the tumor with five recoveries and two deaths; while seven were not subjected to operation and the lesion was found at autopsy.

F. J., (24299) N. Y. H. The patient was a 29 year old man who entered the hospital on March 17, 1933, with recurrence of a tumor removed in 1928 from his left anterior chest wall. The wound never completely healed. Two years after the first operation he noticed a similar growth on the right, which gradually grew, and eight months before admission an enlargement lateral to his original scar. There was apparently no pain or other symptoms from the presence of the tumor.

Physical examination showed the left side of the chest not as well developed as the right. There was a broad flat scar in the midclavicular line over the right costochondral junction, from which a crust could be lifted, leaving a moist surface. No sinus tract could be found. There was a lump on either side of the scar, irregular and hard. The larger one contained

a small amount of soft flocculent material. Roentgenograms showed an extensive tumor formation along the anterior chest wall on the right, near the midline in the region of the seventh, eighth and ninth costal cartilages with apparently no involvement of bony portions of the ribs or of the sternum or xyphoid process.

On March 22, 1933, thoracotomy was done and the tumor was found to be densely adherent to the pleura and at its upper margin to the lung. A large section of the anterior chest wall, including the tumor, the scar of the previous operation and portions of the fifth and sixth ribs, was removed. Microscopic examination revealed the tumor to be an enchondroma invading the bone upon which it abutted without evidence of malignancy.

Convalescence was complicated by hemothorax, empyema and infection of the wound but the patient was discharged in good condition and has been well since. (Figs. 14 and 15.)

MEDIASTINAL LIPOMAS

In a paper on the subject published in 1933, one of us (G. J. H.) described a mediastinal lipoma weighing approximately twelve and one-half pounds occurring in a young girl of 24. A search of the literature at that time showed that twenty-eight cases of intrathoracic lipoma previously had been reported. In the literature since 1933 we have found, including our own case, fourteen additional cases, bringing the total number at the present time up to forty-two. In forty of the forty-two cases the original articles were available to us; in two cases, those of Auvray cited by Garré and of Chiari cited by Gussenbauer, were not available.

A review of these cases shows that it is indeed difficult from the published case reports to make dogmatic statements regarding their exact origin. They have been described as subpleural lipomas, diaphragmatic lipomas, pericardial lipomas, bronchogenic lipomas and so on, depending upon the opinion of the reporter. Surveying the entire series one gains the impression that with one or two exceptions these tumors had their origin in the mediastinum and certainly occupied the mediastinum. They are here considered, therefore, as mediastinal lipomas. A further impression is gained that many of them are congenital tumors.

According to their location and form the lipomas may conveniently be divided into three groups: first, a group in which an intrathoracic tumor is continuous with an extrathoracic tumor giving rise to an hour-glass form; second, a group in which a mediastinal tumor

extends upward into the neck; and third, a group in which the tumor lies entirely within the thoracic cage.

1. *The Hour-Glass or Dumbbell Lipomas.* Of the forty-two cases, thirteen belong to this group. They are characterized by possessing two masses connected by a constricted portion or isthmus. The one mass lies within the mediastinum, the other lies external to the bony thorax and is visible and palpable. The constricted portion occupies a perforation in the thoracic wall, usually between the ribs. In size both external and internal portions of the tumor have varied greatly. The external tumor mass presents over the anterior, lateral or posterior aspects of the thorax and has been described as varying in size from that of a walnut to that of an adult head. The internal mass occupies some part of the mediastinum and has been described as large as an infant's head. The tumors have been found in children as early as six months of age and in adults up to sixty years of age. Because of their position within and without the thoracic cage, interesting speculations have arisen regarding their origin and development. The theory which to us appears most satisfactory is to consider the hour-glass type of lipoma as a congenital tumor appearing before the bony structures of the thorax have fully developed. The tumor, therefore, plays a passive role, being impinged upon and constricted during the development of the thorax in such a way as to form an extra and intrathoracic tumor. Analagous tumors elsewhere in the body (hour-glass tumors of the spine, hour-glass fibrolipomas in association with spina bifida occulta, intracranial and extracranial dermoids, etc.) support this theory.

2. *The superior mediastinal lipomas* presenting at the root of the neck. Of the forty-two cases, five belong to this group. The tumors apparently arise in the anterior mediastinum and extend upward, presenting as visible and palpable tumors, either directly above the manubrium or to one side of the substernal notch. They have, for the most part, been observed in adults. In size the tumors have varied up to a "quart cup."

3. *The Intrathoracic Lipomas.* Of the forty-two cases, twenty-four belong to this group. They are scattered through the literature from 1783 to the present time and often are incompletely recorded. In the majority the condition was not diagnosed during life and the tumor found at autopsy. In ten a diagnosis of intrathoracic tumor was made, but not a positive diagnosis of lipoma. In size the tumors vary greatly. In our case the tumor measured 25 × 25 × 13 cm. and

weighed twelve and one-half pounds; in Leopold's case the tumor weighed seventeen and one-half pounds. Other described tumors were small and probably did not provoke symptoms.

The clinical manifestations of the lipomas are, of course, dependent upon their form, size and location. The first and second groups described above present external tumors which are visible and palpable. Their internal or mediastinal portions cause compression symptoms or not depending on their size or particular location. This applies equally to the third group in which the tumor lies wholly within the mediastinum. Symptoms referable to the mediastinum are those common to all tumors. Pain in the chest, dyspnea, cyanosis, paroxysmal cough and choking spells all occur. A noteworthy finding is the long duration of symptoms indicative both of early origin and slow growth. A number of cases gave a history of definite dyspnea of from twelve to twenty years' duration, before coming under observation. Because of this slow growth and their soft consistency the lipomas may reach an enormous size and produce an astonishing degree of compression of the lungs and other intrathoracic structures; but because this takes place so gradually, symptoms may develop only very slowly. As noted, Leopold's case revealed at autopsy a tumor weighing seventeen and one-half pounds. The patient before death presented an astonishing degree of dyspnea and cyanosis in addition to ascites and edema of the abdominal wall, genitalia and legs.

A correct diagnosis of lipoma has been made but rarely and only in cases with external tumors. The long history of slowly increasing pressure symptoms may be suggestive. The study of the tumor shadow in two of our cases led to a guess as to the true nature of the lesion; for the characteristic feature of the shadow is that it becomes distinctly less opaque toward the periphery, suggesting a tissue more readily penetrable than the more compact tissue of fibromas or other tumors within the mediastinum.

Of the thirteen cases of hour-glass lipomas, twelve patients were subjected to operation; one was discovered at autopsy. In nine of the twelve patients operated upon, both the external and internal tumor were removed; in three cases only the external tumor was removed. Seven patients recovered and were cured and five died. Four of the five patients who died did so as a result of infection. They were all operated upon between 1856 and 1889 before aseptic surgery had been developed.

Of the five cases with tumors presenting at the root of the neck, three patients were subjected to operation, one was treated by *x*-ray and one was found at autopsy. In the three patients subjected to surgery the tumor was removed and the patients recovered. The patient subjected to *x*-ray therapy died.

Of the twenty-four cases of intrathoracic lipoma, sixteen patients died untreated with respect to their tumors which were discovered at autopsy. Eight patients were subjected to operation and the tumors removed, of whom five recovered and three died. It is to be noted that this summary of mediastinal lipomas covers a long period, a part of which antidates the *x*-ray and aseptic surgical technic. With our present facilities the lipomas should be a particularly favorable group from the viewpoint of surgical treatment.

F. E., (14732) N. Y. H. The patient was a 23 year old girl who entered the hospital on December 5, 1932, with a history of pains in the chest, shortness of breath and choking sensations of ten months' duration, beginning with a sharp pain and pressure symptoms in the left chest and intensified at the beginning of each menstrual period. Repeated aspirations which were performed at other hospitals where she went for observation failed to reveal the presence of fluid in the chest.

Physical examination showed a patient who was cyanotic and somewhat dyspneic; the trachea was shifted to the right. Expansion was limited in the lower anterior chest and absent in the left chest posteriorly. There was a marked bulge in the upper anterior thoracic wall. Left chest dulness on percussion was marked, the breath sounds were absent in the left axilla and left back, and numerous wet rales were heard at the right base; voice sounds were diminished over the left chest. The heart sounds were of good quality but rapid. An *x*-ray showed the trachea and heart displaced to the right and the entire left lung field obscured homogenously.

After the patient had been gotten into the best possible condition, a thoracoplasty was done under local anesthesia; yellowish mucoid material was first aspirated from the tumor and then a section of the tumor tissue was taken for biopsy. This was diagnosed under microscopic examination as a lipoma.

On January 5, 1933, an attempt was made to remove the tumor surgically but while novocain was being injected into the intercostal space inferior to the sixth rib, the patient moaned and underwent tonic and clonic convulsions and, in spite of all attempts to resuscitate her, she died within a few minutes.

Autopsy showed the tumor measuring 25 cm. both longitudinally and transversely at its widest diameters, occupying most of the chest cavity and apparently originating in the anterior mediastinum. Microscopic

FIG. 16. N. Y. H. 14732, F. E. Lipoma. (From *Ann. Surg.*, 98: 801, 1933.)

FIG. 17. N. Y. H. 14732, F. E. Lipoma. (From *Ann. Surg.*, 98: 801, 1933.)

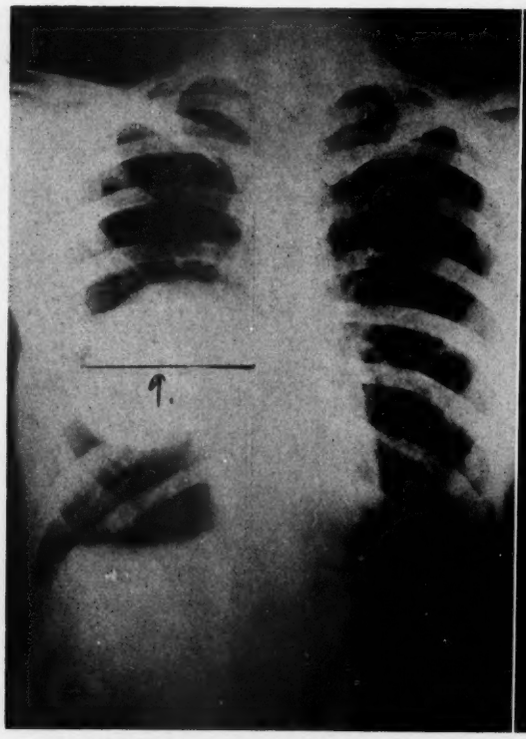

FIG. 18. N. Y. H. 137071, V. P. Liposarcoma.

FIG. 19. N. Y. H. 137071, V. P. Liposarcoma.

examination of the tissue showed the tumor to be a lipoma. (Figs. 16 and 17.)

V. P., (137071) N. Y. H. This patient, a woman of 27 years, was admitted on August 13, 1936, complaining of pain in her lower back. During a recent upper respiratory infection, her physician had made a diagnosis of thoracic tumor.

Physical examination showed nothing noteworthy except slight dulness to percussion over the posterior right chest. Breath sounds in the lower right axilla and at the base of the right lung were suppressed.

The patient was given an artificial pneumothorax and fluoroscopy showed a well-defined smooth rounded mass in the right chest. At operation a mediastinal tumor was removed. The patient did well after operation but developed a fistula which delayed her recovery. This has subsequently healed completely. The pathologic report of the tumor was liposarcoma. (Figs. 18 and 19.)

NEUROGENIC TUMORS

The mediastinum may be the site of a variety of tumors which have their origin in elements of the nervous system. Because the thorax contains nerves of both the somatic and autonomic systems, and in addition in the paravertebral ganglionic chain and in the cardiac and pulmonary plexuses, ganglion cells in profusion, all these elements must be considered in tracing the derivation of such tumors. The connective tissue elements of these structures should also be included in any complete survey of the precursors of the type cells of tumors of neurogenic origin.

In the embryo the autonomic ganglions are derived from the medulary epithelium by way of the neural or ganglionic crest cells which migrate outward to the sites of future ganglions and plexuses where they receive fibers from the spinal cord and brain stem and whence they, in turn, send out fibers to the various structures which they supply. In the course of this process the cells undergo a series of developmental changes from primitive undifferentiated cells through the cell types spoken of as sympathicoblasts (sympathigonia) and neuroblasts, to the adult type of sympathetic ganglion cell. The distance over which this migration takes place is so great as distinctly to favor faulty development resulting in "rests" of immature cells potentially capable of proliferation. The various steps in this maturation are set forth in Figure 20.

The intercostal nerves are composed of fibers of cells in the gray matter of the cord or in the ganglions of the posterior roots, both

derived from the medullary epithelium—the latter by way of the neural crest.

The sheaths of the peripheral nerves, three in number—the

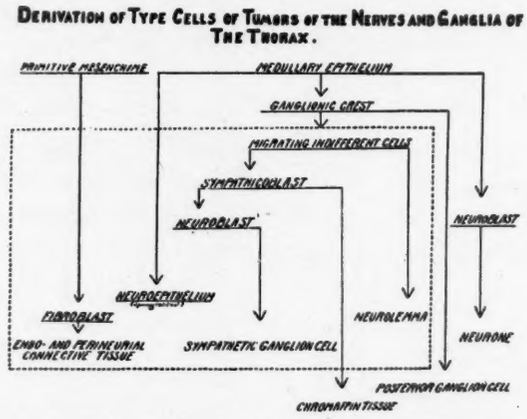

FIG. 20. Chart showing derivation of neurogenic tumors. (From *J. Thoracic Surg.*, 6: 381, 1937.)

myelin sheath, the sheath of Schwann and the connective tissue sheath—are of quite different anatomic origin and physiologic significance. The myelin sheath belongs properly to the axis cylinder and has a similar derivation. The sheath of Schwann, on the other hand, develops from the medullary epithelium by way of the ganglionic crest, while the connective tissue sheath (Henle's sheath) is of mesodermal origin and composes the endoneurium and perineurium.

The sympathicoblasts (sympathigonia) give rise not only to the cells of the sympathetic nervous system but also to the chromaffin tissue of the adrenal medulla, the carotid and coccygeal bodies and the "Gelbenzellen" of the intestinal tract.

These, then, are the precursors of type cells to be found normally as constituents of the adult nerve structures in the chest. As previously indicated, however, their process of development is extremely complicated; and one might expect that occasionally cells would be carried into the chest of a kind also derived from the medullary epithelium normally found only in the central nervous system, or its immediate outpouchings such as the retina. Only on such a hypothesis can we explain the presence in the chest of a tumor such as a neuroepithelioma composed of primitive spongioblasts.

The various elements of the ganglions are bound together by connective tissue and the nerve trunks themselves contain a considerable amount of fibrous tissue forming the endoneurium and perineurium. This tissue develops from the primitive mesenchyma

and may give rise here as elsewhere to any of the tumors of the fibroblastic series.

If one prepares a table such as appears in Figure 20, tracing the embryological derivation of the elements of the nervous structures within the chest, one finds that the dotted line encloses the type cells of practically all the neurogenic tumors occurring in the mediastinum, and that the higher the type cell lies in the chart, the more malignant is the tumor. Our own series contains examples of each type and comprises the more benign group including the ganglioneuromas, Schwannomas or neurinomas and the neurofibromas as well as the malignant tumors such as the neuroblastomas, sympathicoblastomas, neuroepitheliomas and neurogenic sarcomas. All these tumors have certain characteristics in common in that they arise most frequently in the posterior mediastinum, where, with the paravertebral ganglionic chain as well as the intercostal nerves, a considerable amount of nerve tissue is concentrated. Also, due to their frequent origin from the thoracic spinal nerves or ganglia, they may protrude into the spinal canal as well as into the chest, giving rise to the so-called hour-glass tumors. As these latter growths constitute a special group from the standpoint of symptoms, signs and treatment, they will be considered elsewhere; but it should be born in mind that any tumors arising from connective tissue or nervous elements in or near the intervertebral foramina may assume such configuration and that the group, therefore, constitutes an anatomic though not a pathologic entity.

The clinical picture in the benign tumors of neurogenic origin gives little or no indication as to the exact type of tumor present. Many of them remain asymptomatic and are picked up only in the course of routine *x*-rays of the chest; some begin to give symptoms during convalescence from a respiratory infection, while in others the symptoms are those of a complicating pulmonary infection. In others, definite symptoms are present early, most commonly beginning with pain or some other symptom of pressure on nerve structures such as a Horner's syndrome, hoarseness or an irritative cough. Large tumors may produce symptoms and signs of pressure on other mediastinal structures with dislocation of the trachea or compression of the larger bronchi. Perhaps because of their slow growth or because many are discovered before attaining great size, symptoms of severe mediastinal compression are not common with benign neurogenic tumors.

The *x*-ray examination reveals a shadow of even density and smooth curved outline located most commonly in the paravertebral gutter and in the upper part of the chest. Except on the basis of the relative frequency of the various types of tumors, no differential diagnosis is possible. With such a characteristic shadow, however, the likelihood that the tumor is benign is very good, although one must bear in mind that malignant tumors such as neurogenic sarcomas or fibrosarcomas or even primary bronchogenic carcinomas may present such a picture in the *x*-ray. Erosion of bony structures suggest malignancy, and this is particularly true when the transverse processes or bodies of the vertebrae are involved; but the benign fibromas, when they arise from the perineurium of intercostal nerves, may cause some pressure erosion of the ribs above and below their point of origin.

NEUROFIBROMA

The typical neurofibroma is seen in von Recklinghausen's disease and appears as a tumor arising from a nerve and containing any or all of the constituents of the nerve trunk. Such tumors are thought to originate primarily from the perineurial or endoneurial fibrous tissue and vary considerably in their composition. Thus, many are very largely fibrous or they may be a concomitant overgrowth of nerve fibers producing a mixed picture. In some the fibrous tissue may undergo degeneration with the production of myxomatous tissue or malignant changes may occur resulting in sarcoma. In the chest in by far the greater number of reported instances the tumor has been solitary, but in some the nerves of the thorax have shared in a typical widespread involvement of the peripheral nerves in the neurofibromatosis of von Recklinghausen's disease.

While no doubt some of the neurofibromas may have been diagnosed as pure fibroma, we have been able to collect from the literature twenty authentic instances of intrathoracic neurofibromas and add a case of our own. These tumors have been quite uniformly distributed among the various age groups and have been encountered in children less than ten years of age; six were found in patients over fifty. Seventy-seven per cent of the tumors occurred in females. While most of them have been of moderate size, some have reached enormous proportions—one measuring $20 \times 15 \times 9.5$ cm. and weighing 170 Gm.

The symptoms, signs and *x*-ray findings are those of benign mediastinal tumor and are not distinctive for this particular variety of neoplasm. The true nature of the tumor is sometimes suggested,

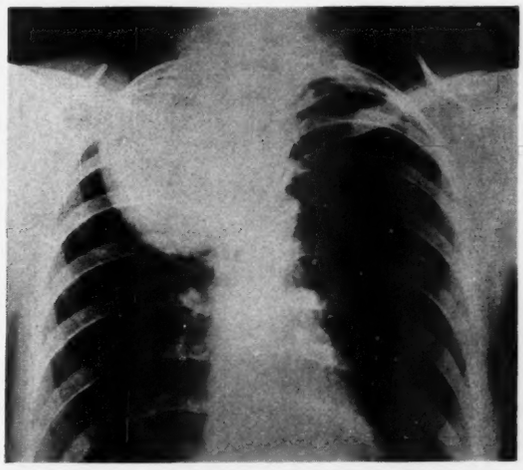

FIG. 21. N. Y. H. 54442, H. O. Myxoneurofibroma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

however, when it arises from one of the intercostal nerves near the spine, as in such circumstances some pressure erosion of the ribs immediately above and below the site or origin of the growth may be visible in the *x*-ray.

Four of the twenty-one cases were found at autopsy while seventeen patients were operated upon and the tumor removed. Five of these, or 29.4 per cent, died following operation but the remaining twelve (70.6 per cent) recovered.

An example of this type of tumor in our series was seen in a woman thirty-nine years of age:

H. O., (54442) N. Y. H. This patient was admitted to the hospital on February 7, 1934, complaining of frequent sudden attacks of bronchitis with unproductive cough over a period of ten years, and also periodic attacks of vertigo not associated with vomiting or loss of consciousness, during the past year. A typical Horner's syndrome on the right had developed during the past fifteen years.

The past history was not remarkable except for severe menorrhagia in 1931, at which time a diagnosis of fibroids of the uterus was made and radium therapy given, inducing artificial menopause.

Physical examination revealed signs of compression in the area of the right upper pulmonary lobe and *x*-rays of the chest showed a large solid

tumor occupying about three-fourths of the right upper chest, slightly displacing the trachea.

On May 3, 1934, the tumor was removed and found to be a myxoneurofibroma with no indication of malignancy. Convalescence was uneventful and the patient was discharged on the thirty-fifth day after operation with the wound healed but no change in the Horner's syndrome. Ten months after operation the patient wrote that she felt quite well except that she still had a slight tendency to bronchitis and slight dizziness. The pathologic report on the tumor was myxoneurofibroma. It apparently arose from the paravertebral sympathetic chain. (Fig. 21.)

GANGLIONEUROMA

This type of tumor which originates from the sympathetic ganglia has been identified with increasing frequency in recent years as more and more cases are being attacked. For a time it was felt to occur more frequently outside of the thorax, but we have been able to find sixty-eight instances of intrathoracic ganglioneuromas including one of our own.

These tumors arise in the upper part of the posterior mediastinum and lie upon the upper thoracic vertebrae and ribs. As they increase in size they extend laterally and when large, may completely fill the upper portion of the chest. In the reported cases the tumors have varied in size from 5 × 3 × 1 cm. to 17 × 12 × 8 cm. and in weight from 110 Gm. to 2 Kg. They are well encapsulated and of firm consistency, but in some a fairly dense outer shell has surrounded a mass of softer tissue. The cut surface is gray and glistening and appears to be relatively avascular with irregular lobulation. On microscopic section one sees typically rather coarsely arranged fibrous tissue intermingled with strands of medullated and non-medullated nerve fibers, the latter type being commonly the more numerous. Interspersed between these elements are seen multipolar ganglion cells varying in number in different tumors and many of them showing signs of degenerative changes such as vacuolization.

Particularly in recent years these tumors have been found more frequently in children. Thus, of the thirty-six patients in this series whose age is stated, 74 per cent were children under ten years of age. Females predominate in a ratio of 3:2.

True ganglioneuromas are benign but as they tend to increase in size they should be removed, preferably as soon as recognized. Furthermore, in the neurogenic tumors as a group, there may be relatively wide variations so far as their composition is concerned.

Some appear clinically and on gross examination to be benign and microscopically are found to contain a preponderance of immature or even embryonic cells.

In our collected series of sixty-eight cases, fourteen were found at autopsy or the patients died untreated, while fifty-one were subjected to operation. Of these sixteen or 31 per cent died while the remaining 69 per cent recovered. The majority of the operative fatalities have been due to shock or to hemorrhage occurring during the operation. This commonly results from tearing of mediastinal vessels in the process of freeing the tumor and can be avoided if the mediastinal attachment of the growth is freed last and after a braided silk snare is placed around its mesial aspect and used as a tourniquet. The growth can then be removed by cutting across distal to the snare and the blood vessels of the pedicle ligated in a dry field.

K. S., (182475) N. Y. H. A typical example of this group of tumors was encountered in a 3½ year old girl admitted to the Pediatric Service of the hospital for pneumonia and who was first suspected of having an intrathoracic tumor when a shadow in the upper portion of the right chest failed to clear up after the pneumonia had subsided. *X*-ray films then appeared as seen in Figure 22. Operation was undertaken and through a posterior approach with excision of portions of the third, fourth, fifth and sixth ribs, the tumor was exposed. The parietal pleura was reflected from the growth and after placing a snare about the mediastinal aspect, the capsule was incised just distal to the snare and the tumor removed. The vessels of the pedicle were then ligated and the wound in the chest wall closed without drainage. After operation it was noted that the child presented a Horner's syndrome on the right due, no doubt, to injury to the upper paravertebral sympathetic ganglia in the course of the operative procedure. (Figs. 22 and 23.)

NEURINOMA (SCHWANNOMA, LEMMOMA)

Tumors arising from the cells of the sheath of Schwann also have the gross characteristics of the fibromas, but present a different histologic picture. The Schwann cells are believed to be derived from the neural crest and are thus of ectodermal origin. They make up a specific stroma of the peripheral nerves and are considered by many to be analogous here to the true neuroglia of the central nervous system. The true neurinoma is seen as a nodular elongated enlargement of a nerve or as a rounded mass projecting from its trunk. Two types can be distinguished microscopically. One is made up of elongated fusiform cells often with many vacuoles which give a

foamy appearance to the cytoplasm and with their nuclei arranged side by side in "palisades." In this type also the cells may be arranged in whorls known as "Verocay bodies" and resemble those seen in meningiomas. The second or Antoni type of neurinoma shows considerable mucoid degeneration and may resemble a myxoma.

These tumors are much more frequently encountered in peripheral nerves and in the spinal canal than within the thorax. Indeed, in some of the nineteen intrathoracic cases which we have been able to find in the literature, the tumors were of the hour-glass variety comprising an intraspinal as well as an intrathoracic mass. There was no significant sex or age incidence among this series which would be of any aid in suggesting the specific type of neoplasm present, the diagnostic features being the same as those of other solid benign tumors such as the neurofibromas. Like these tumors they may vary considerably in size and are sometimes quite large. In one case the tumor measured 20 × 15 × 14 cm. and weighed 1700 Gm.

Four of the nineteen instances of this tumor were found at autopsy while fifteen patients were subjected to operation. In fourteen of the cases the tumors were successfully removed and the patients recovered, but the other patient died.

The malignant tumors composed of primitive elements of the nervous system are also encountered within the thorax as illustrated in the following case:

B. C., (94646) N. Y. H. The patient was a 9 year old Jewish boy who for fourteen months before admission had increasingly severe pains in the thoracic region of the spine.

Four days before admission the left leg became paralyzed; there was considerable generalized pain in both lower extremities.

Physical examination on admission was negative except for slight thoracolumnar kyphosis and chest findings which were: percussion note dull from the spine to the tip of the scapula and extending from the fourth to the seventh vertebra; breath sounds were suppressed under this region. *X*-rays showed a dense tumor mass extending chiefly to the left of the bodies of the sixth to ninth thoracic vertebrae. Slight extension of the tumor mass on the right also was evident. The mass was well-defined and made up of several layers. There was a slight scoliosis to the right in this region and some erosion of the left pedicle of the eighth segment.

By the fourth day after admission the signs of cord compression at about the level of the sixth dorsal vertebra had become clear. In spite of a rise in temperature for which no cause could be found, a laminectomy and partial resection of the cord tumor was performed—partial because collapse

FIG. 22. N. Y. H. 182475, K. S. Ganglioneuroma.

FIG. 23. N. Y. H. 182475, K. S. Ganglioneuroma.

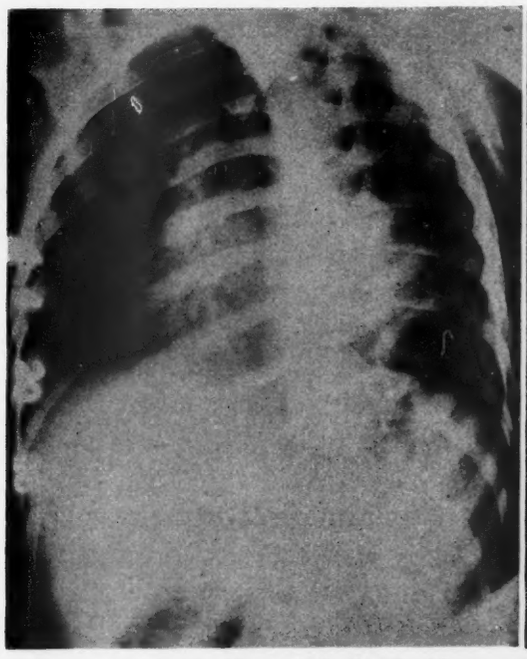

FIG. 24. N. Y. H. 94646, B. C. Neuroblastoma.

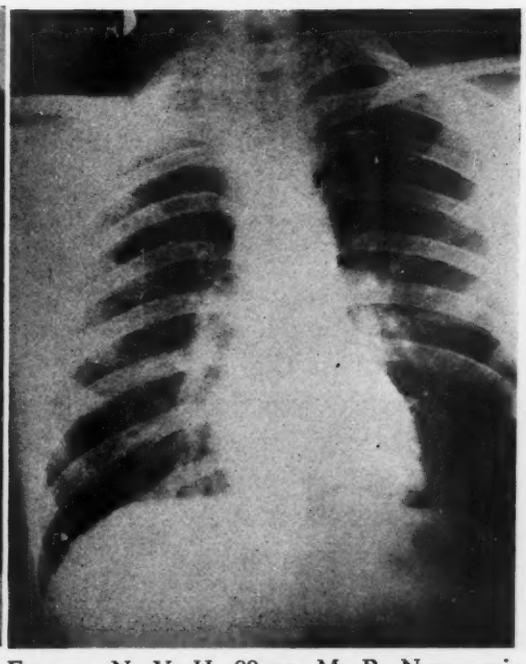

FIG. 25. N. Y. H. 88739, M. B. Neurogenic fibrosarcoma. (From *Surg., Gynec. & Obst.*, 67: 577, 1938.)

of the patient made immediate withdrawal imperative. The tumor was found to lie between the sixth and ninth dorsal segments and to constrict the cord at the left of the eighth segment.

The postoperative course was progressively downhill. Despite transfusions and other supportive measures the patient died on the sixth day after operation.

Autopsy showed the tumor to be a neuroblastoma with extension into the posterior mediastinum and into the overlying pleura of the lung. (Fig. 24.)

TUMORS AT THE APEX OF THE CHEST (PANCOAST TUMOR, SUPERIOR SULCUS TUMOR)

Pancoast first described the typical syndrome associated with certain tumors at the apex of the chest, consisting of unilateral pain in the shoulder girdle and upper extremity, Horner's syndrome, paresis of the hand and the presence of an abnormal roentgenographic apical shadow, and himself designated these growths as superior sulcus tumors. While the syndrome is definite and consistent, experience shows that it is not produced, as Pancoast inferred, by a special kind of tumor arising from structures other than the lung, pleura, ribs or mediastinum, but rather that any type of neoplasm occupying the mesial portion of the thoracic apex is capable of producing this symptom complex. It is, therefore, to be thought of as a geographical rather than a pathologic entity.

The apex of the lung covered by the pleura protrudes through the narrow thoracic aperture bounded by the u-shaped first rib, the body of the first thoracic vertebra and the superior mediastinum and subclavian vessels and the eighth cervical and first thoracic nerves pass laterally over the arch of the pleura. The first and second intercostal nerves emerge just mesial to the apex and the upper ganglia of the thoracic sympathetic chain are in immediate proximity with the recurrent laryngeal and phrenic nerves just anterior. So many structures lie in this comparatively small space in the posteromesial portion of the apex that a small tumor may press upon several at once.

From the report of Ray, who has collected reports of more than fifty such cases from the literature and added five more from this clinic, it is evident that in the majority this symptom complex is caused by primary bronchogenic carcinoma which has invaded through the parietal pleura at the posteromesial portion of the apex.

Other tumors responsible have included neurogenic tumors, carcinomas arising in substernal goiters, carcinomas arising from branchiogenic rests and pleural endotheliomas, as well as a variety of metastatic neoplasms.

The most important symptoms are those of pressure on nerves, and the first of these both in importance and in time of appearance is pain described variously as boring, gnawing, deep-seated or shooting and due to irritation of the first to the fourth thoracic nerves. This pain increases in severity until it becomes unbearable and requires large doses of opiates for its amelioration. In the early stages, signs of irritation of the sympathetic chain such as dilatation of the pupil or excessive sweating may precede the development of typical Horner's syndrome—ptosis and myosis and absence of sweating. The source and progress of the symptoms have been analyzed by Ray to whose paper the reader is referred for details.

The *x*-ray shows some abnormal shadow at the thoracic apex varying from a vague thickening of the mesial portion of the apex of the lung field to a more extensive involvement of the upper lobe. In many instances erosion of the transverse processes or bodies of the upper thoracic vertebrae is evident.

Except for the occasional benign tumor which produces the milder type of symptoms and which can be excised, the treatment of such cases is largely palliative. A number have been explored and biopsies taken, but such procedures have usually been followed by an increase of symptoms. The wisest treatment consists in section of the posterior roots of the nerves involved since this at least results in complete relief of pain.

M. B., (88739) N. Y. H. This patient, a physician 30 years of age, was admitted to the hospital in August, 1936, complaining of pains in his chest. He had had three unexplained attacks of right spontaneous pneumothorax over a period of five years. The initial pain was over the right scapula and subsequently in the right upper chest and inner side of the arm. There was disappearance of sweating on the right side of the body above the nipple line and right Horner's syndrome.

Operation revealed a stony hard tumor protruding through the space between the vertebral ends of the second and third ribs and invading the surrounding muscles.

A specimen was taken for biopsy and showed, on microscopic section, neurogenic fibrosarcoma. After operation the pain continued until death in February, 1937. The pathologic report of the biopsy specimen was neurogenic fibrosarcoma. (Fig. 25.)

THE HOUR-GLASS TUMORS OF THE SPINE

The term, "hour-glass tumors of the spine," is used to designate a group of tumors which occur within a certain region and give rise to certain clinical manifestations. It does not imply a pathologic classification for the tumors are varied in kind. It is applied to tumors which arise along the spine from the highest cervical to the lower sacral vertebrae either from within the spinal canal, from the vertebrae or from without the spine. Arising intraspinally they extend outward through an intervertebral foramen or between two adjoining laminae to form a paravertebral tumor; or arising paravertebrally they extend through an intervertebral foramina into the spinal canal to form there an intraspinal growth. At the point where they penetrate the intervertebral foramina, the tumors are constricted and assume, therefore, an hour-glass shape. We are concerned here only with the tumors of this kind which, arising either intraspinally or paravertebraly, extend into the mediastinum.

Pathologically, these tumors vary in their nature. In a study made by one of us (G. J. H.) some years ago it was found that they were described as neurinomas, neurofibromas, neuromas, fibromas, ganglioneuromas, lipomas, chondromas, fibrosarcomas, spongioblastomas, neuroblastomas and leiomyomas. Grouping them according to their possible origin it appears that the hour-glass tumors may arise from the membranes, ganglia and nerve roots of the spinal cord, from the ligaments and fasciae in or about the vertebrae, from the cartilage of the articular surfaces of the vertebrae and ribs, from the intraspinal epidural fat and from the sympathetic nervous system. To these true tumors must be added a small group of echinococcic cysts which have occurred in this region. The great majority of the tumors thus far described have been benign encapsulated growths; a few have been definitely malignant.

In 1929 one of us (G. J. H.) found thirty cases reported in which the paravertebral portion of the tumor encroached upon the mediastinal space. Since then, cases have been reported from time to time but we have not made an effort completely to assemble them. The largest single series is that reported by Naffziger and Brown who in 1933 reported fifteen cases. Of these, five cases presented a paravertebral tumor extending into the mediastinum; a sixth case presented a large and presumably a tumor shadow which at autopsy proved to be an old tuberculous process unrelated to the hour-glass

tumor of the spine; and a seventh case presented a mediastinal mass which proved to be a carcinoma, probably originating in the lung. An interesting group of cases which was overlooked in our former paper are the echinococcic cysts of the spine, seven of which had the hour-glass form, caused compression symptoms with reference to the spinal cord and presented paravertebral extensions into the mediastinum. We have observed four cases ourselves: one a neurofibroma, one an unverified malignant tumor, one a chondroma and one a spongioblastoma.

The symptoms provoked by these tumors have been predominantly those of involvement of the spinal cord. Pain in the back and in the distribution of implicated spinal nerves, paresis or paralysis of the extremities and changes in sensation and reflexes have, in practically all cases, been the symptoms and clinical signs which have brought the patient to the doctor and have justified the diagnosis of extramedullary spinal cord tumor. Symptoms referable to the thorax such as pain, cough, dyspnea and cyanosis in the large tumors have been absent in the small paravertebral tumors. Physical signs such as dulness on percussion over the thorax are present and do not depend upon the size of the tumor. In the early cases (30) collected, these signs were present in four, stated to have been absent in sixteen and not mentioned in nine. In the same group of cases an *x*-ray of the chest positively demonstrated the mediastinal tumor in sixteen, and failed to show it in one case; in twelve cases there are no records of *x*-ray examinations. In three of our four cases the *x*-ray showed the tumor, in one failed to do so; but it is to be noted that only a single anteroposterior film was made. A lateral film would have demonstrated it.

It is apparent from the foregoing discussion that the diagnosis may be missed unless the occurrence of these tumors is borne in mind. A clinical manifestation being that of compression of the spinal cord, the diagnosis of cord tumor must certainly be made; but unless the mediastinal portion of the tumor is sufficiently large to cause symptoms and physical signs referable to the thorax, it may be overlooked. From the experience in the literature which our own experience confirms, anteroposterior or lateral *x*-ray films of the chest in cases of spinal cord tumor, will serve to visualize the mediastinal portion of the hour-glass tumors, and this additional examination is recommended.

In the thirty cases of hour-glass tumors we have referred to, operation was undertaken in twenty-six. In seventeen cases the intraspinal and mediastinal parts of the tumor were removed at one sitting through a laminectomy approach, the mediastinal tumor being exposed by the resection of the transverse processes of the spine and, if necessary, the adjacent ribs; in one patient the intraspinal and mediastinal parts of the tumor were removed but at two sittings; in four patients the intraspinal tumor was removed but not the mediastinal; in three patients the mediastinal tumor was removed but not the intraspinal (in one the cord tumor was not found and the patient later died; in two, symptoms were not sufficiently severe to warrant exploration—outcome unknown); in one case the mediastinal tumor was explored but, because of vascularity, was not removed. In this last case treatment was with radium which caused the disappearance of the cord symptoms but not the disappearance of the mediastinal tumor; but there was freedom from symptoms for five years. There were seven deaths in 26 patients, a rather high mortality; but it is to be remembered that some of the patients were operated upon a good many years ago. Of our four cases, in one an operation was not performed due to the poor condition of the patient; in two patients the intraspinal and mediastinal tumors were removed at one sitting; in one (spongioblastoma) a part of the intraspinal tumor only was removed. This case was given 2000 R units through the open wound while the patient was on the operating table. She is free from all symptoms two and one-half years after operation. Naffziger's seven patients were subjected to operation. In one the intraspinal and mediastinal tumors were removed with recovery; in one the intraspinal tumor was removed, the mediastinal tumor partially removed with recovery; in two the intraspinal tumor was removed, the mediastinal tumor was not removed with one recovery and one death; and in three patients the intraspinal tumor was partially removed, the mediastinal tumor not removed with one recovery and two deaths.

Of the seven cases of hour-glass echinococcic cysts, five patients died with symptoms of spinal cord compression without having been subjected to surgery and came to autopsy. In all there presented an echinococcic cyst compressing the spinal cord connected with a paravertebral cyst lying in the mediastinum. Two patients were subjected to operation with one recovery and one death. From the

experience thus far gained, surgery would appear the treatment of choice; especially in view of the fact that the large majority of the tumors are benign and not likely favorably to be influenced by *x*-ray therapy. In carrying out surgical procedures, the primary approach should be directed to the removal of the tumor compressing the spinal cord not only because of the urgency of the cord symptoms but because of the possibility of removing through the primary incision and at the same time the paravertebral tumor.

M. Y., (180675) N. Y. H. This woman, aged 64 years, was admitted to the hospital on October 16, 1937, complaining of pains in the left chest for 5 or 6 weeks. She also had difficulty with micturition and evacuation of her bowels. Her legs were almost entirely paralyzed.

Physical examination showed a slight hypertensive cardiovascular disturbance and evidence of cord compression at the fifth and sixth dorsal vertebrae.

A laminectomy was performed under local anesthesia on October 2, 1937, and portions of an infiltrating, extradural tumor mass removed from around the cord. The dura was not opened. *X*-ray therapy was instituted on the operating table through the open wound and later at frequent intervals.

The neurogenic symptoms disappeared and the tumor was seen on *x*-ray to have almost completely vanished.

Two years after operation the patient was in good condition without recurring neurogenic symptoms. The pathologic report of the tumor was glioblastoma multiforme. (Fig. 26.)

TUMORS OF THE THYMUS GLAND

In the present paper we shall omit consideration of the thymic hyperplasias as expressed by enlarged thymus and persistent thymus, as described in association with so-called status lymphaticus and as observed in exophthalmic goiter, and confine ourselves only to the tumors of the thymus gland.

A review of the literature shows the difficulty of presenting very clearly and simply a pathologic classification of the thymic tumors. Without attempting to discuss their pathology, which would take us beyond the scope of this paper, we present as a working classification that of Foot taken from a recent publication. It is more complicated than the earlier classification of Ewing but only in so far that it includes additional groups of tumors.

NON-MALIGNANT THYMOMAS

Aside from thymic rests, either *in situ* or ectopic, and of the choristoma variety, there are reports of tumors composed of disarranged though otherwise practically normal thymic tissue. The thymic reticulum cells tend to lie peripherally, the thymocytes centrally in the lobules, reversing the normal situs. Thymic corpuscles are usually present and have the characteristic appearance. The eosinophilic thymic cells are apparently somewhat in eclipse in these tumors, although a careful search may reveal their presence.

MALIGNANT THYMOMAS

1. *Thymocytic or Lymphocytic Type.* These are composed of small, round cells with deeply staining nuclei. Ewing believes that they are darker than lymphocytes. Hassall's corpuscles may or may not be present.

2. *Large-Celled or Lymphoblastic Type.* These are made up of large, rounded, ovoid cells resembling lymphoblasts or primitive thymic reticulum cells. Thymic corpuscles may or may not be found.

3. *Thymic Reticulum Cell Type.* The cell of this small group closely resembles the entodermal thymic reticulum cell, and the group is probably the largest and most frequently occurring of the malignant thymomas. It has been reported in man as well as in several animals, notably the chicken, cow, horse and sheep. Feldman states that the cow seems to be most frequently affected. The cells for these tumors are more pleiomorphic ranging from spheroidal to spindle-shaped, or multipolar and stellate. They may often form duct-like structures that are so definitely epithelial in their appearance that Schminke included these tumors in his new group of "lymphoepitheliomas." Thymic corpuscles are variably present.

4. *Perithelial Type.* This had been reported by Symmers in eight of his twenty-five cases, and by Matras and Priesel (Case 5) and Laas, although the foreign authors do not refer to it as such. It shows definitely perithelial arrangement of radially directed fusiform cells about its vessels (be it noted, without interpolated areas of necrosis) and is quite characteristic in appearance. Thymic corpuscles do not play an important role in this tumor.

5. *Granulomatous Type.* Symmers has collected five cases of Hodgkin's granuloma in the thymus. There may be others in the literature reported in connection with Hodgkin's disease and, there-

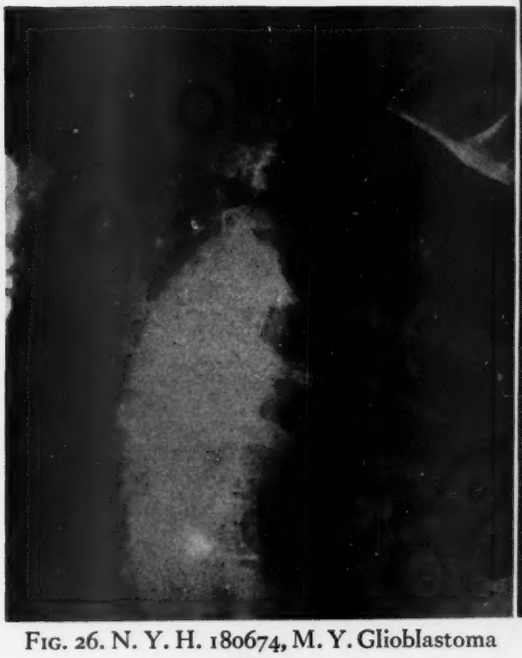

FIG. 26. N. Y. H. 180674, M. Y. Glioblastoma multiforme.

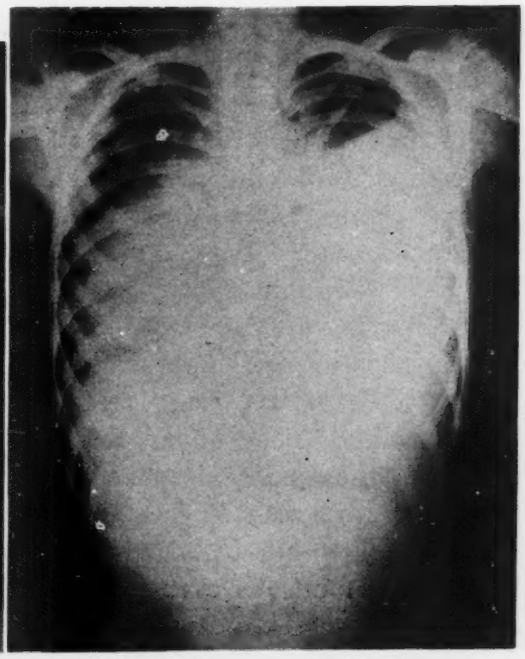

FIG. 27. N. Y. H. 147070, T. M. Thymoma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

FIG. 28. N. Y. H. 45318, N. G. Hodgkin's granuloma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

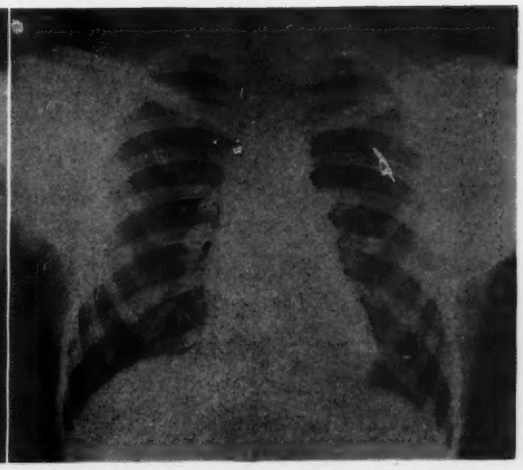

FIG. 29. N. Y. H. 45318, N. G. Hodgkin's granuloma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

fore, missed in our review. The picture is that of Hodgkin's granuloma located in the thymus or at its site.

6. *Epithelial or Carcinomatous Type.* These are tumors of elderly subjects and resemble epidermoid carcinoma as they are composed of innumerable thymic corpuscles in all stages of development and degeneration, thus creating a "pearly" appearance. The thymic reticulum cells may form radiating cords from such pearls, which sometimes have duct-like arrangement, and, with a liberal admixture of lymphocytoid elements, may shift the picture toward that of the "lymphoepithelioma" of Schminke.

7. *Teratoid Type.* Here all the elements of the normal thymus are found to be undergoing abnormal proliferation, and they are often thoroughly disguised. The proliferation may be distributed through all the elements, or it may preponderate in one or two. In addition to quasi-normal components, duct or gland-like structures may be found, or even solid medullary plugs of pale, rather delicate epithelium. These tumors seem to be more frequent in young individuals. Margolis suggests that ducts of this sort might be found in normal thymus and indicate the presence of rests that might later give rise to tumors of this sort. His reported tumor was quite rich in such structures, which were less prominent though present in a case by Foot and Harrington.

BENIGN OR NON-MALIGNANT THYMOMAS

The benign tumors of the thymus, judging from the reports in the literature, occur less commonly than the malignant tumors. As they have been described, they have been associated with myasthenia gravis in some cases, not associated with this condition in other cases. Due, probably, to their relationship with an interesting disease, the tumors associated with myasthenia gravis have been more carefully collected and we shall speak of them first.

Thymic Tumors in Myasthenia Gravis. In 1901, Weigert reported a case of myasthenia gravis with a thymic tumor and numerous foci of lymphocytes in the skeletal muscles. Bell described a case in 1917 and collected the cases from the literature. He found that between 1901 and 1917, fifty-seven patients, dying with the symptoms of myasthenia gravis, had been subjected to autopsy; and that of the fifty-seven patients, the thymus was enlarged in seventeen, and contained a tumor in eleven. In one half of the cases, therefore, either an enlargement of the thymus or tumor was found. Blalock et

al., in 1939, reported a case of myasthenia gravis with an intrathoracic shadow which, at operation, proved to be a cystic tumor in the position of the thymus, the successful removal of which has been followed by disappearance of the symptoms of myasthenia gravis. He and his coauthors collected twenty-six additional cases (including their own) in which myasthenia gravis was associated with a lesion of the thymus. Of the total fifty-four cases in which a lesion of the thymus has been associated with myasthenia gravis, a tumor has been present in thirty-two, an enlargement or persistent thymus in twenty-two.

These tumors have shown various pathologic pictures. The tumor in Bell's case is described as occupying the position of the thymus, measured $6 \times 4 \times 3.5$ cm. and weighed 60 Gm. It was definitely encapsulated. The cut surface was soft in consistency, light gray in color and showed many hemorrhagic areas. Microscopic section showed a tumor tissue composed of cells with large vesicular nucleii and abundant light-staining cytoplasm, the whole fused together to form a syncitium. Throughout it were numerous spaces of variable size and shape containing small lymphocytes. No Hassall's corpuscles were seen. The tumor is called a benign thymoma suggestive of an adenoma. Of the cases in the literature at least five resemble Bell's case. Bell is of the opinion that the tumors in myasthenia gravis form a distinct group of comparatively small benign growths composed of young thymic tissue. Norris considers that the pathologic changes in the thymus are of the nature of a hyperplasia, which, when extreme, may give rise to an encapsulated tumor mass. Of the tumors reported in association with myasthenia gravis, all except one appear to be benign; the exception is Meggendorfer's case reported in 1908, which is called a large-cell sarcoma and which in its growth, extension and metastases, presented the characteristics of the malignant thymoma.

In addition to the benign tumors seen in myasthenia gravis are others which are not associated with this disease. These are fewer in number. There is no evidence which we can find that pathologically they are essentially different from the tumors seen in myasthenia gravis. An example of the largest tumor of this sort thus far reported, is one successfully removed by one of us (W. DeW. A.). A brief abstract of this case will follow.

Clinically we must again differentiate the tumors with and without the signs and symptoms of myasthenia gravis. In the former

group and because of the finding of lesions of the thymus in one-half of the autopsied cases of myasthenia gravis, the clinical manifestations of this disease should suggest the possible presence of a thymic tumor. The tumors themselves have been small, only two having been reported as large tumors, and, therefore, not likely to give rise to mediastinal compression symptoms. The *x*-rays reported show spherical circumscribed shadows in the anterior mediastinum immediately behind the sternum and in contact with the superior part of the pericardium.

In the tumors not associated with myasthenia gravis the clinical manifestations depend more or less upon the size of the lesion. In the small tumors, symptoms may be mild or absent, in the larger tumors they may be severe. A good example of the large benign tumor is the case just referred to.

T. M., (147070). A school boy, 13 years of age, was admitted to the New York Hospital October 14, 1936, suffering from dyspnea, orthopnea and weakness of seven months' duration. He had been well up to the age of 7 when he had scarlet fever, and following this measles and chicken pox. Since then he had been frail; at the age of 9 he was fluoroscoped by his family physician who told his parents that he had "thymic gland trouble." He became easily fatigued, and became short of breath on exertion. He had only a slight cough without expectoration or hemoptysis. During some seven months prior to admission his symptoms increased particularly the dyspnea and orthopnea. The latter was most marked at night so that he slept propped up in bed. There had not been any pain in the chest.

Examination showed the trachea displaced to the right, the left half of the chest full and with restricted respiratory movements. The cardiac and superior mediastinal dullness were displaced to the right. The heart sounds were best heard in the fourth and fifth interspaces to the right of the sternum. The left lung field was entirely flat on percussion below the first rib anteriorly and below the spine of the scapula posteriorly. Over the area of flatness the breath sounds were absent. The diaphragm seemed to be displaced downwards. *X*-rays of the chest showed a huge mass occupying the entire left hemithorax except at the extreme apex and base, dislocating the heart and mediastinal structures to the right. The central portion of the shadow was denser than the peripheral. Two aspiration biopsies failed to yield sufficient tissue for study although a few large cells and lymphocytes suggesting thymic tissue were noted. The diagnosis was not positively established. The great size of the tumor with the late development of compression symptoms suggested a slow growing soft tumor like a lipoma and it was with this diagnosis that operation was undertaken.

The operation was performed November 6, 1936, under intratracheal anesthesia, and the entire tumor successfully removed. The tumor was a large, encapsulated, yellowish-white, lobulated growth weighing 2235 Gm. and measuring 26 × 24 × 7.5 cm. in its various diameters. On microscopic section the tumor was found to be made up of islands of thymoid tissue surrounded by adipose tissue. The tissue making up the scattered islands approached normal thymus. There were small thymocytes in abundance, thymic reticulum cells, and thymic corpuscles in every stage of development and involution. A diagnosis of benign thymoma was made. The boy has been perfectly well since operation. (Fig. 27.)

There are but few cases of benign tumor of the thymus in which a surgical attack has been undertaken. Alder reported a case of myasthenia gravis in which a benign thymic tumor, the size of a child's head, was removed by Sauerbruch. The patient died eight days after operation from mediastinitis. Obeditsch reported a case in which a tumor, the size of a man's fist, was removed by Sauerbruch, the patient dying five days later from a streptococcic infection. The case we have just described is the first, so far as we can discover, in which a benign thymic tumor has successfully been removed. Blalock's case is the second successful surgical attempt. The association in his case of myasthenia gravis and the disappearance of the symptoms of this disease following the removal of the tumor adds to the evidence of a relationship between the two conditions, but is not, of course, conclusive.

MALIGNANT THYMOMAS

Rubashow, in 1911, reported a case and collected sixty-nine cases of malignant thymoma from the literature. They included thirty-three cases collected by Hoffman up to 1896. Among them were fifty-two sarcomas, twelve carcinomas and seven miscellaneous tumors. Foot, in 1926, reported four cases, reviewed the literature and found that, if the miscellaneous cases of Rubashow are excluded, there were eighty-one cases of primary malignant thymic tumors reported. Crosby, in 1932, again reviewed the subject and found 166 cases, 122 of which he classified as sarcoma and forty-four as carcinoma. Decker, in 1935, brought the number to 208. Since 1935 we have found nineteen additional cases and have observed two of our own bringing the number to 230.

Pathologically, the tumors include the lymphosarcomas, the most frequent variety, the carcinomas and the sarcomas arising pre-

sumably from the connective tissue stroma of the thymus. To these are to be added the granulomatous tumors as Hodgkin's disease, the teratoid tumors or carcinosarcomas and other variously described malignant conditions. Generally speaking their growth within the mediastinum is somewhat similar. The tumors occupy the anterior mediastinum. Anteriorly they may, in their growth, exert pressure upon and cause protrusion of the sternum and even perforate the bone. Posteriorly the tumors sooner or later surround the trachea, bronchi, pericardium and great vessels, and at times also the esophagus. They vary in size but in the majority of instances they have at autopsy pretty well filled the mediastinum. They are commonly hard nodular or lobulated tumors, but the rapidly growing tumors may be soft, vascular and hemorrhagic. Encapsulation within the mediastinum has been observed but the more malignant forms become adherent to the surrounding organs and invade the pleura, lung and pericardium, large vessels and trachea. Metastases to distant organs have not been common but occasionally metastases in the liver, spleen, adrenal, pancreas and kidney have been observed.

The age of onset has been variable. The teratoid type of tumors have occurred early in life and the majority of sarcomas appear in young people. The carcinomas occur later and in the majority of cases in individuals over fifty years of age. The symptoms may be chiefly or entirely thoracic and due to mediastinal compression. Pain in the chest, cough and dyspnea are the common symptoms which increase gradually or rapidly. Engorgement of the veins of the neck and upper thorax, hoarseness, difficulty in swallowing and eventually edema of the extremities may appear. A pleural effusion may occur; fever, loss in weight and strength and anemia may supervene. While the thoracic symptoms predominate, there usually occurs before death some external evidence of the mediastinal tumor as fullness in the suprasternal notch or enlargement of the glands of the neck or axilla. In some cases external evidence of the disease may antedate thoracic symptoms, i.e., swelling of the neck, a tumor which perforates the sternum or thoracic wall or enlargement of the glands of the neck. In these cases symptoms referable to the chest appear sooner or later and gradually or rapidly progress. Death due to suffocation is the common termination. The clinical course has usually been rapid and death may occur in two or three months after the patient comes under observation. One of Ewing's patients, however, lived two years.

The physical findings need not be detailed. Since the tumor occupies a central position in the anterior mediastinum there is dulness behind and to either side of the sternum. The signs of pleural effusion may be present at either base. The *x*-ray shows a shadow occupying the upper mediastinum extending a variable distance downward from the sternal notch and laterally beyond the margins of the sternum. The diagnosis of primary thymic tumor has apparently rarely been made before death although the presence of a mediastinal tumor is of course evident. In a few cases partial excision of an external tumor has led either to a correct diagnosis or at least to a diagnosis of lymphosarcoma. The treatment has been unsatisfactory. We have found some eight recent cases in which surgery was undertaken with a fatal outcome in each, and from our own experience and autopsy reports it is evident that removal would be possible only in the very early stages of the disease. From the reports in the literature, radiotherapy also has not been very successful; and we thus far have failed to find a case in which improvement over any considerable period has occurred.

LYMPHOMA, LYMPHOCYTOMA, LYMPHOSARCOMA, HODGKIN'S DISEASE

There still remains a good deal of confusion regarding the various conditions arising from lymphoid tissues; and although we have again attempted a survey of the literature we are not able to present definitely the frequency, origin and pathologic picture of the various lesions arising from the mediastinal lymph glands. Baldridge and Awe classify the lymphomatous tissues pathologically, recognizing a sclerosing type as Hodgkin's disease, an endothelial type as in lympho-epithelioma, a lymphoblastic type as in lymphosarcoma, and a lymphocytic type with and without leukemia. Ewing classifies the tumors according to their origin from the three anatomic elements in lymphoid tissue capable of originating lymphoid tumors, i.e., lymphocytes, reticulum cells of follicles and pulp and endothelial cells of pulp and cavernous sinuses. From the lymphocytes may originate the simple lymphomas, the malignant lymphocytomas and the leukemias; from the reticulum cells, myeloid leukemia, malignant granuloma, Hodgkin's disease and large cell lymphosarcoma and from the endothelial cells, the endotheliomas. To attempt to place the tumors of the mediastinal lymph nodes described in the literature in either of these classifications is, as we have noted, a difficult and

profitless task. We shall confine ourselves, therefore, to a limited discussion of these lesions, emphasizing those which in our experience are more commonly observed.

SIMPLE LYMPHOMA

This benign tumor as occurring in the neck, axilla and groin must be rare in the mediastinum and we have not, thus far, found a certified case described.

MALIGNANT LYMPHOCYTOMA

In this group may be included the malignant lymphocytomas, not otherwise designated, the malignant lymph-adenomas and possibly the small-celled tumors of the thymus associated with lymphatic leukemia. This is a clinical rather than a strictly pathologic grouping but is made necessary by the paucity of details in the pathologic descriptions. The pathologic basis for the group is the predominance in the mediastinal tumors of small cells resembling lymphocytes; but whether these small cells are derived from lymph nodes or thymus is not often clearly stated.

The tumors arise as a rule in the anterior mediastinum, often in the general location of the thymus. They vary in size from moderate to large tumors spreading upwards to the neck and downward to or over the pericardium. They may fill the space between the sternum and spine and encroach laterally upon the lungs; and they show a tendency, like the malignant thymomas and lymphosarcomas, to surround the trachea, great vessels and esophagus which, although constricted by the tumor, may not be directly involved for a considerable period. The tumors by extension may invade the pleura, lung, pericardium and glands of the neck and axilla and may metastasize to the lungs, liver, spleen and other organs. They consist of a single or lobulated mass, white or slightly yellowish or grayish-white on section, which presents a uniform surface marked by strands of connective tissue. In a few cases, areas of necrosis have been described. Microscopically, the picture has varied, resembling in general that of a sarcoma with the predominant cells of the small lymphocyte type.

LYMPHOSARCOMA

This must be considered one of the common malignant mediastinal tumors. In a series of 145 cases of mediastinal tumor seen in the

Medical and Surgical Wards of the New York Hospital, forty-seven or 32 per cent are diagnosed as primary malignant disease of the mediastinal lymph nodes and of the forty-seven, eighteen are diagnosed as lymphosarcoma, twenty-nine as Hodgkin's disease. An attempt to collect all the cases from the literature has not been made but it is evident from a general review of the literature that they number in the hundreds.

The origin of the mediastinal lymphosarcomas is not always clear. They may arise either from the mediastinal lymph nodes or the thymus gland. Most commonly they have their origin in the anterior mediastinum and, at first small, they grow rapidly, extending upward to the neck and downward to or over the pericardium to the diaphragm. They extend posteriorly, surrounding the great vessels, trachea and esophagus and may come to fill the space between sternum and spine. Laterally they may extend to and involve the pleura and lung and in the majority of cases do so before death occurs. At autopsy in advanced cases the entire mediastinum may be occupied by a solid tumor mass which involves anterior and posterior mediastinal and bronchial glands and within which may be seen on transverse section the cross section of the great vessels, trachea, bronchi, esophagus and vagus nerves. One is surprised to find that, while these structures are constricted and compressed, their walls are rarely directly infiltrated. The great veins also may escape, but are more likely to be invaded and thrombosed. Extensions of the tumor may present in the neck, in one or both axillae and as retroperitoneal masses below the level of the diaphragm. Metastases may occur to lungs, liver, spleen and other organs.

The tumor mass is as a rule hard and on section presents a white, grayish-white or yellowish-white surface. Necrosis is not the rule, but in large bulky tumors areas of necrosis may be present. On microscopic section there appears "a diffuse growth of lymphoid cells lying in reticular tissue. The structure of the affected nodes or follicles is obliterated. The cells vary in size being small, medium or large. The nucleii are compact or vesicular, always hyperchromatic and nucleoli are not prominent. Large multinuclear cells are occasionally seen." (Ewing.)

The symptomatology of the malignant lymphocytoma which was omitted, is similar to that of the lymphosarcoma, so that the clinical manifestations of the two conditions may be considered together. A

review of the symptoms of mediastinal lymphosarcoma makes it difficult to present a constant clinical picture. The condition is seen most commonly between thirty and fifty years of age and twice as often in males as in females. The chief symptoms are pain, tumor or swelling and signs of mediastinal compression. There is the greatest variation in the time of appearance of these symptoms. In one case pain in the chest or behind the sternum or simulating intercostal neuralgia may be the initial symptom to be followed by the appearance of a swelling in the neck and cough, dyspnea and cyanosis. Again a swelling in the neck at the suprasternal notch may be the first sign to be followed by others. Not infrequently cough with a slight amount of expectoration and dyspnea on exertion are the first evidences of the condition.

As the disease progresses the symptoms become more exaggerated. Pain is dull and aching or sharp and paroxysmal. Tumor is a less constant finding; but visible, palpable tumors may occur in the neck, axilla, over the sternum due to its perforation or to the side of the sternum due to the perforation of rib or intercostal space. Cough and dyspnea increase and are associated with cyanosis; and hoarseness due to pressure on the recurrent laryngeal nerve, dysphagia due to compression of the esophagus, vomiting due to vagal irritation, occasionally hiccough and eye changes due to involvement of the sympathetic nerve, may all supervene. Sudden edema of the face and neck may appear at any time in the course of the disease. Swelling of the abdomen and legs with an accumulation of fluid in the peritoneal cavity usually occur late in the disease. Hemoptysis is commonly present and, although seldom severe, was directly responsible for death in 3 per cent of Rose's cases. Emaciation more often is absent. Fever of a low grade is the rule but we have observed a continuously high fever. A leucocytosis of from 10,000 to 15,000 not uncommonly has been observed.

The physical signs, of course, depend upon the size and location of the lesion. A number of cases are reported in which a small tumor so situated as to compress a bronchus has caused symptoms but has failed to give any physical signs, and the lesion has been found at autopsy. The majority of cases, however, present themselves with definite signs. On inspection the face and neck may be suffused, swollen or cyanotic. A tumor in the neck or over the sternum may be evident. One side of the thorax may bulge or be retracted and show

restriction of respiratory movements. Dilatation of the veins of the neck and upper thorax, Horner's syndrome and hoarseness may be evident. Dyspnea may be the most distressing of all symptoms.

Palpation may establish the presence of a swelling in the neck or axilla. Percussion demonstrates the submanubrial dulness indicative of a growth in the superior mediastinum; auscultation may show harsh respiratory sounds as evidence of bronchial compression, and rales indicative of an associated bronchitis. The *x*-ray shows a shadow which occupies the mediastinum and which may be sharp and circumscribed or diffuse. Pleural effusion, sometimes hemorrhagic, is a common complication and may be evident on physical or *x*-ray examination. Tumor cells may be present in it. A chylous effusion due to occlusion of the thoracic duct was noted in one case.

The diagnosis of mediastinal tumor is usually not difficult, but its identification as a lymphosarcoma may remain in doubt. The removal of an enlarged gland wherever accessible will most quickly establish the diagnosis. Should no external gland be available, the careful aspiration of the tumor with a large trocar at a point where it presents beyond the sternum or in the suprasternal notch may yield tissue which will certify the lesion. Should this method also fail we have to fall back on diagnosis by exclusion.

The prognosis is poor. The disease progresses rapidly and is a fatal malady. In Rose's series the average duration of the disease from the first symptom until death was thirty-two weeks. Forty-three patients died of exhaustion, eleven of asphyxia, three of hemorrhage, two of cardiac failure and one of cerebral tumor.

Surgery has thus far achieved little in the treatment of malignant lymphosarcoma and lymphocytoma. A few cases have been subjected to surgery but the attempt at extirpation was abandoned because of the extent of the lesion. At the present time *x*-ray and radium would appear to be the only means of treating these lesions. It is well known that the tumors arising from lymphoid tissues respond favorably to *x*-ray and radium therapy and there are many reports in the literature, which our own experience confirms, of the decrease in size or the total disappearance of the mediastinal shadows, with a corresponding improvement in symptoms. The improvement, however, in our experience is temporary and we have not yet observed a cure.

P. I., (80347) N. Y. H. The patient was a 34 year old man who was admitted to the hospital November 5, 1934, with a complaint of substernal

soreness unassociated with activity or respiration of four weeks' duration. Three weeks before admission he became suddenly short of breath and began to notice an aching pain between the shoulder blades while walking up stairs. He had had a dry, non-productive cough during the past four weeks but no fever, night sweats or hemoptysis. His appetite had been poor. On examination he did not appear ill and was suffering from no apparent respiratory distress, but there were the classical signs of effusion in the left pleural cavities.

During his stay in the hospital thoracentesis was performed repeatedly, fluid rapidly accumulating. *X*-ray therapy was instituted, a total of 3795 R units being administered to the chest over a period of three months. Fluid ceased accumulating in his chest. Biopsy of an axillary lymph node yielded a diagnosis of lymphosarcoma. During his stay he developed left otitis media with facial palsy, Horner's syndrome on the left, thrombophlebitis of the left arm with swelling of the arm and face, ascites, and finally a low-grade fever. Toward the end of his life he was greatly troubled by nausea and vomiting, and although his caloric intake was good, he steadily lost weight. He expired on the one hundred seventy-fifth hospital day.

Anatomical diagnosis at autopsy was lymphosarcoma involving mediastinal, cervical, mesenteric, retroperitoneal and inguinal lymph nodes; lymphosarcomatous infiltration of liver, kidneys, spleen and pancreas; pleural effusion, bilateral; adhesive pleurisy over the entire left lung with lymphosarcomatous infiltration; peripelvic hemorrhages of kidneys; adhesive pericarditis with pericardial ecchymoses; congestion and edema of the left lung, and ascites.

HODGKIN'S DISEASE

It is not within the scope of this paper to take up in detail the various manifestations of Hodgkin's granuloma. As is well known, the disease presents a definite histologic picture which is regarded as pathognomonic of the condition. Microscopic sections show diffuse cellular hyperplasia with varying proportions of proliferating endothelial cells, endothelial giant cells, plasma cells and eosinophilic leucocytes. The disease, beginning usually with the enlargement of a chain of lymph nodes, most often in the neck, spreads to the axillary, inguinal, bronchial, mediastinal and retroperitoneal glands. A splenic tumor develops in 60 to 70 per cent of the cases, as does enlargement of the liver. With the generalization of the disease, fever, night sweats, anemia and cachexia appear.

Mediastinal Hodgkin's disease is but one manifestation of this disease. In a few cases the mediastinum appears to be the primary seat of the disease which may progress insidiously until pressure

symptoms call attention to it. Much more frequently the mediastinal glands become involved secondarily to the cervical and axillary glands so that the disease is well established before symptoms referable to the mediastinum become evident. The enlarged glands here as elsewhere may remain discrete and consist of a mass of individual glands loosely held together by connective tissue, or the disease may show invasive qualities and form a large solid mass which surrounds the trachea, bronchi and great vessels. Mediastinal tumors of this sort may form the chief lesion of Hodgkin's disease, filling the mediastinum and compressing its various structures. Extensions to the pleura, lungs, pericardium and heart muscle have been observed.

The symptomatology and physical signs resemble those in lymphosarcoma and reference may be made to our comments under this subject. The *x*-ray of the chest shows as a rule, a broad sharply defined mediastinal shadow usually quadrilateral in shape and extending from the cardiac shadow upward to the neck. The diagnosis often can be made from the clinical picture alone, but the histologic study of a gland removed for biopsy, remains the most certain means of diagnosis.

X-ray or radium treatment remains at present the best form of therapy. It is gratifying in some cases to observe the rapid reduction in size and even the complete disappearance of large mediastinal masses causing compression symptoms and to witness the cessation of urgent and distressing symptoms. In our experience and, it would appear, in the experience of the majority of observers, *x*-ray treatment is after all but palliative; for the mediastinal mass, in course of time, reappears and the patient dies of the disease. The duration of life, however, may be prolonged up to five or more years.

N. G., (45318) N. Y. H. The patient was a 15 year old boy who had been treated for diabetes with insulin and diet for two years previous to admission. Two years earlier at about the time of the onset of the diabetes, the patient first noticed a slight pain at the base of the left side of the neck. This pain soon went away and a swelling appeared. Six months later a painless swelling was felt in the left axilla. During the next nine months the patient received eight *x*-ray treatments for these swellings, during which time they gradually increased in size but had periods of remission. During the eight months following *x*-ray treatments the patient had severe itching, especially of the thighs, and weakness after moderate exercise. No other symptoms were present.

Physical examination on admission showed an area of dulness in the right chest and the mediastinum enlarged to percussion. *X*-rays of the chest

showed a very large mediastinal shadow extending outward from the right hilum and to a lesser extent from the left hilum. Biopsy showed a picture typical of Hodgkin's granuloma.

During his hospital course, the blood sugar was controlled with insulin and diet. After the diagnosis of Hodgkin's disease had been established by biopsy, he received a treatment of deep *x*-ray therapy and was discharged to return for further therapy. Three months after discharge the *x*-ray showed no appreciable change in the size of the process at the right hilum, although the density appeared slightly increased. (Figs. 28 and 29.)

SARCOMAS

The primary sarcomas of the mediastinum, as distinguished from the metastatic sarcomas, form a miscellaneous group of malignant tumors. They may arise from the connective tissue elements of the mediastinal lymph glands, from the thymus, from the connective tissue of the blood vessels and other structures, and from the tendons and periosteum of the sternum, ribs and spine. They may arise also through the malignant degeneration of the benign connective tissue tumors, particularly the fibromas, xanthomas and chondromas, and of the neurogenic tumors such as the neurofibromas and ganglioneuromas. We have already discussed the sarcomas of the thymus and the lymphosarcomas and have called attention to the sarcomatous degeneration of the benign mediastinal tumors. We shall concern ourselves here with other sarcomas which we have observed and collected from the literature.

In our own experience such other sarcomas are rare. In 145 cases of tumor of the mediastinum in our New York Hospital series, but seven are positively diagnosed as sarcoma and of these three are the result of sarcomatous degeneration of previously benign tumors. Of the remaining four sarcomas, two are diagnosed as liposarcoma and one as an apical sarcoma arising presumably from the sheath of the subclavian artery. In the literature from 1926 to the present time we have found reports of thirty-two cases of sarcoma, seventeen of which are designated as "fibrosarcoma" or "fibroblastoma," thirteen as sarcoma and one each as hemangiosarcoma and liporhabdomyosarcoma.

The tumors occur in the apical region and in the anterior and posterior mediastinum. The apical tumors may extend outward and downward encroaching upon the pleural cavity and compressing the apex of the lung, and in certain cases may give rise to symptoms of the superior sulcus tumors. Those arising from the sternum and costochondral region extend posteriorly and encroach upon the

anterior mediastinum; while those arising from the spine, costovertebral articulation, etc., grow anteriorly and encroach upon the posterior mediastinum. Some of the posterior tumors arise from sheaths of the spinal nerves and they, together with the tumors arising from the connective tissue of the spine, form hour-glass tumors which are described under a separate heading.

The tumors vary in size from very small to large growths. Not infrequently they are circumscribed tumors which in the *x*-ray film represent a clearly defined spherical shadow, and the majority of instances observed by us were tumors of that sort. They may, however, in their growth, break through their capsule and surround and involve the mediastinal structures.

Symptoms depend in part upon their size and the rapidity of their growth. They are those of other mediastinal tumors and consist of pain, cough, dyspnea and other symptoms of mediastinal pressure already referred to. As a rule the symptoms come on more slowly and progress less rapidly than those due to the more malignant lymphosarcomas and may not become urgent for a considerable period of time. The physical signs also resemble those of other tumors except when a tumor, arising posteriorly, extends through an intervertebral foramina causing compression symptoms of the cord, or arising in the apical region gives rise to the characteristic symptoms of the superior sulcus tumors. *X*-rays of the chest in anteroposterior and lateral views may demonstrate the location of the tumor in the anterior or posterior mediastinum and, in some cases, demonstrate its nature.

The diagnosis may be difficult and even impossible. The presence of a tumor, which in all respects including the *x*-ray shadow, resembles the benign tumors we have discussed, makes the differential diagnosis between benign and malignant tumor difficult. Aspiration biopsy, when the location of the tumor is such as to make the procedure safe, may yield positive information. In the late stages of the condition, when invasive extension to other structures has taken place, the diagnosis of malignant tumor may be evident.

Surgical removal in the early stages of the disease would appear to be the treatment of choice. The possibilities of such treatment, when we consider the results obtained in the treatment of other circumscribed but benign tumors, must be evident. Up to the present time, however, the results of surgical treatment have not been brilliant. Of the four sarcomas in our own experience mentioned

above, all were explored; in two, the tumor was satisfactorily removed; in two it was impossible to remove the tumor and a biopsy was done. Of the two in which the tumor was removed, one had a recurrence of the disease about a year after operation and later died; while one is alive and free from recurrence three years later.

Of the thirty-two cases collected since 1926, 19 patients were subjected to operation. In eighteen the tumor was removed with ten recoveries and eight deaths. The late results in those who recovered are not completely stated. Of the seven patients with fibrosarcomas removed with recovery, three died within six months of operation.

SECONDARY OR METASTATIC SARCOMAS

The metastatic sarcomas of the mediastinum are comparatively rare, the lungs being the seat of metastatic nodules so much more frequently. In our own experience there are but few instances in which metastatic nodules have primarily been deposited in the mediastinum, and our survey of the literature would lead us to believe that this generally has been true. We do not think it is necessary to comment upon them.

CARCINOMAS

Like the sarcomas, the carcinomas of the mediastinum form a miscellaneous group of lesions. Primarily they arise from the reticulum cells of the thymus gland; secondarily they may arise as extensions from a primary carcinoma of the lung, trachea or bronchus, breast or esophagus, or as a metastatic growth from primary carcinoma elsewhere.

Primary carcinomas are less common than the lymphosarcomas and other sarcomas. Various authors have, from time to time, collected and studied the cases reported in the literature and have found that the true primary carcinoma of the mediastinum is an infrequent tumor. Crosby, in his study of the malignant tumors of the thymus, found that of 166, 122 were sarcomas and forty-four carcinomas. In Ross' carefully studied series of sixty cases of malignant mediastinal tumor, forty-four are sarcomas and ten carcinomas. While the thymus gland appears to be the chief source of primary carcinomas, other carcinomas, the origin of which is not always clear, may involve the mediastinum. In our series are four superior sulcus tumors which are carcinomatous in nature, the origin of three of which is estab-

lished but the origin of the fourth, an epithelial carcinoma, remains unknown. Other similar cases are reported.

The pathology of the primary mediastinal carcinomas need not be detailed. Like the sarcomas, those arising from the thymus gland may reach a considerable size and filling the anterior mediastinum, may subsequently surround the trachea, bronchi, great vessels, nerves and esophagus. They may extend to the pericardium, pleura and lung and metastasize to the pleura, lung, liver, spleen, kidney and other organs. The superior sulcus tumors have been described in another part of the paper.

The symptomatology of the carcinomas arising from the thymus cannot be differentiated from that of the sarcomas arising from the same structure. This has been discribed under tumors of the thymus and need not here be repeated. The carcinomas occupying the superior sulcus give rise to symptoms and physical signs which are distinctive, and reference may be made to our brief description of the symptomatology of these lesions.

The diagnosis of carcinoma may remain in doubt but it is usually possible to make a diagnosis of malignant disease. In a high percentage of cases the superior sulcus tumors have been carcinomas. The removal of an available gland may establish the correct diagnosis.

The treatment of the carcinomas arising from the thymus gland is unsatisfactory and is pretty well limited to the use of *x*-ray and radium. Of the five cases of superior sulcus tumor in our series, exploration was carried out in all, but more with the purpose of relieving pain by simultaneous division of the proper sensory nerve roots than with the hope of curing the lesion.

SECONDARY MEDIASTINAL CARCINOMAS

In our experience, secondary invasion of the mediastinum has occurred most frequently from primary carcinoma of the bronchus and lung. Carcinoma of the mediastinum also, in our experience, is not infrequent in association with carcinoma of the esophagus. In our explorations for the latter disease, the mediastinal glands frequently have been involved and to such an extent as to make the primary lesion inoperable. We have not, however, in this condition seen the extensive carcinomatous masses described by others, sufficiently large to cause compression symptoms. Primary carcinoma of the breast is another source of mediastinal extensions or metastases which usually occur late in the disease. Metastases from primary

carcinoma in more distant organs may occur, although rarely in the mediastinum.

The metastatic carcinomas require no particular comment. Occasionally the metastatic lesion may give rise to the major symptoms, the primary lesion remaining undiscovered until autopsy reveals it.

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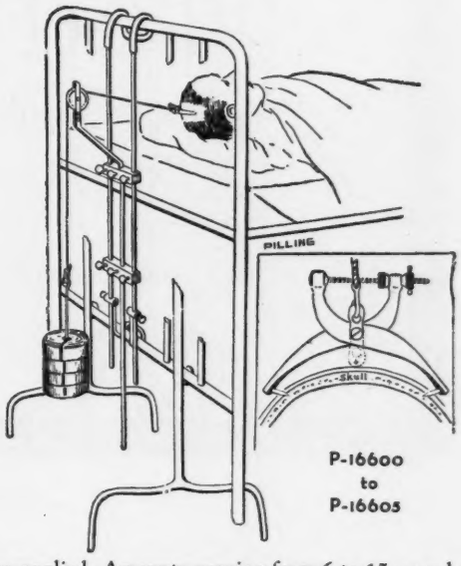

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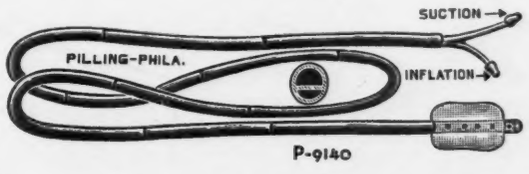

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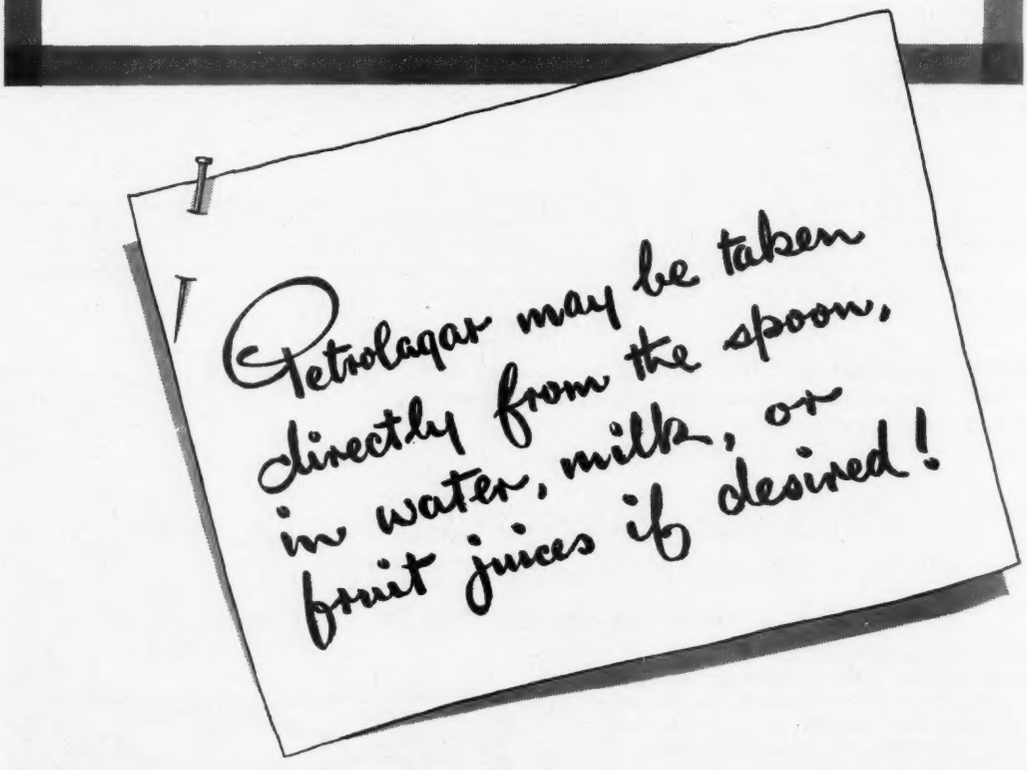
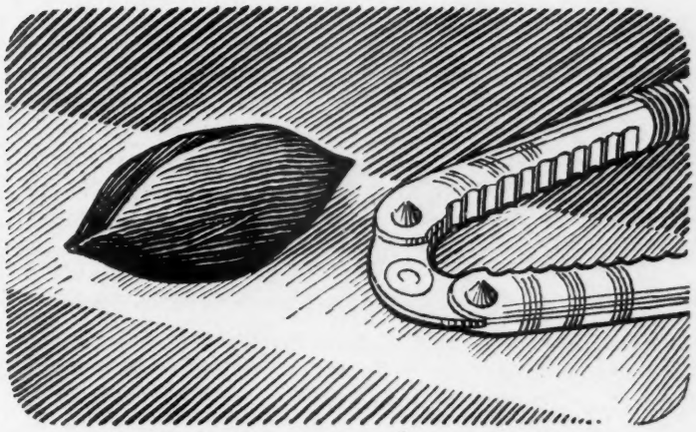


*Petrolagar—The trademark of Petrolagar Laboratories, Inc., for its brand of mineral oil emulsion.
Petrolagar—liquid petrolatum 65 cc. emulsified with 0.4 gm. agar in a menstruum to make 100 cc.



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Rochester, Minn., April 15–17, 1940. (Secy.—Dr. W. Blair Mosser, Kane, Penna.)

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Atlantic City, June 7–8, 1940. (Secy.—Dr. Ralph G. Carothers, 409 Broadway, Cincinnati)

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Skytop, Penna., June 20–22, 1940. (Secy.—Dr. Charles C. Higgins, 2020 East 93rd Street, Cleveland)

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AMERICAN ASSOCIATION OF RAILWAY SURGEONS
Chicago, September 16–18, 1940. (Secy.—Dr. D. B. Moss, 547 W. Jackson Blvd., Chicago)

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Chicago, October 21–25, 1940. (Secy.—Dr. Frederic A. Besley, 215 N. Sheridan Rd., Waukegan, Ill.)

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New York, June 17–19, 1940. (Secy.—Dr. Richard W. TeLinde, 11 East Chase St., Baltimore)

AMERICAN MEDICAL ASSOCIATION
New York, June 10–14, 1940. (Secy.—Dr. Olin West, 535 N. Dearborn Street, Chicago)

AMERICAN ORTHOPAEDIC ASSOCIATION
Kansas City, May 6–9, 1940. (Secy.—Dr. Ralph K. Ghormley, The Mayo Clinic, Rochester, Minn.)

AMERICAN PROCTOLOGIC SOCIETY
Richmond, June 9–11, 1940. (Secy.—Dr. Curtice Rosser, 710 Medical Arts Bldg., Dallas)

THE AMERICAN SOCIETY OF ANESTHETISTS, Inc.
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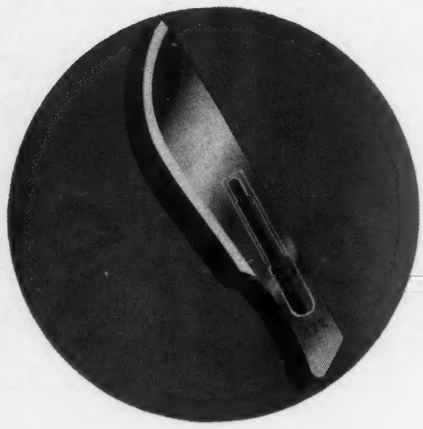

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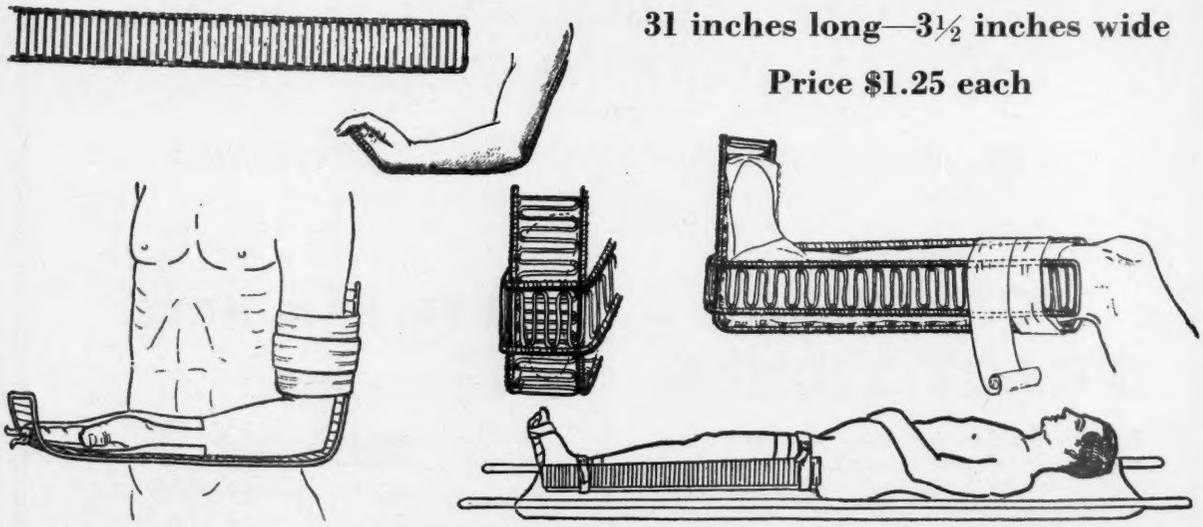

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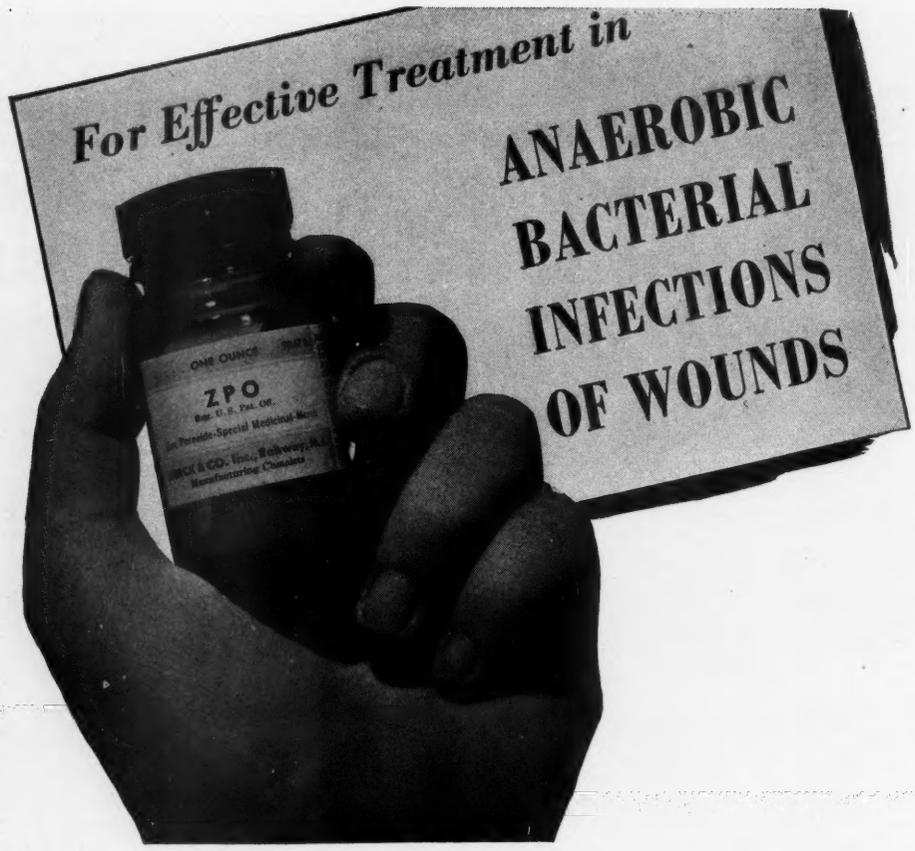

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*Berman, M. S., and Ivy, A. C.: The Toxicity of Various Iodine Solutions, J. Lab. & Clin. Med. 25:113 (Nov.) 1939.

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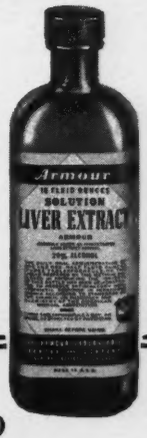

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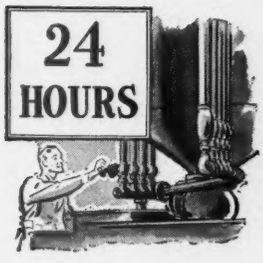

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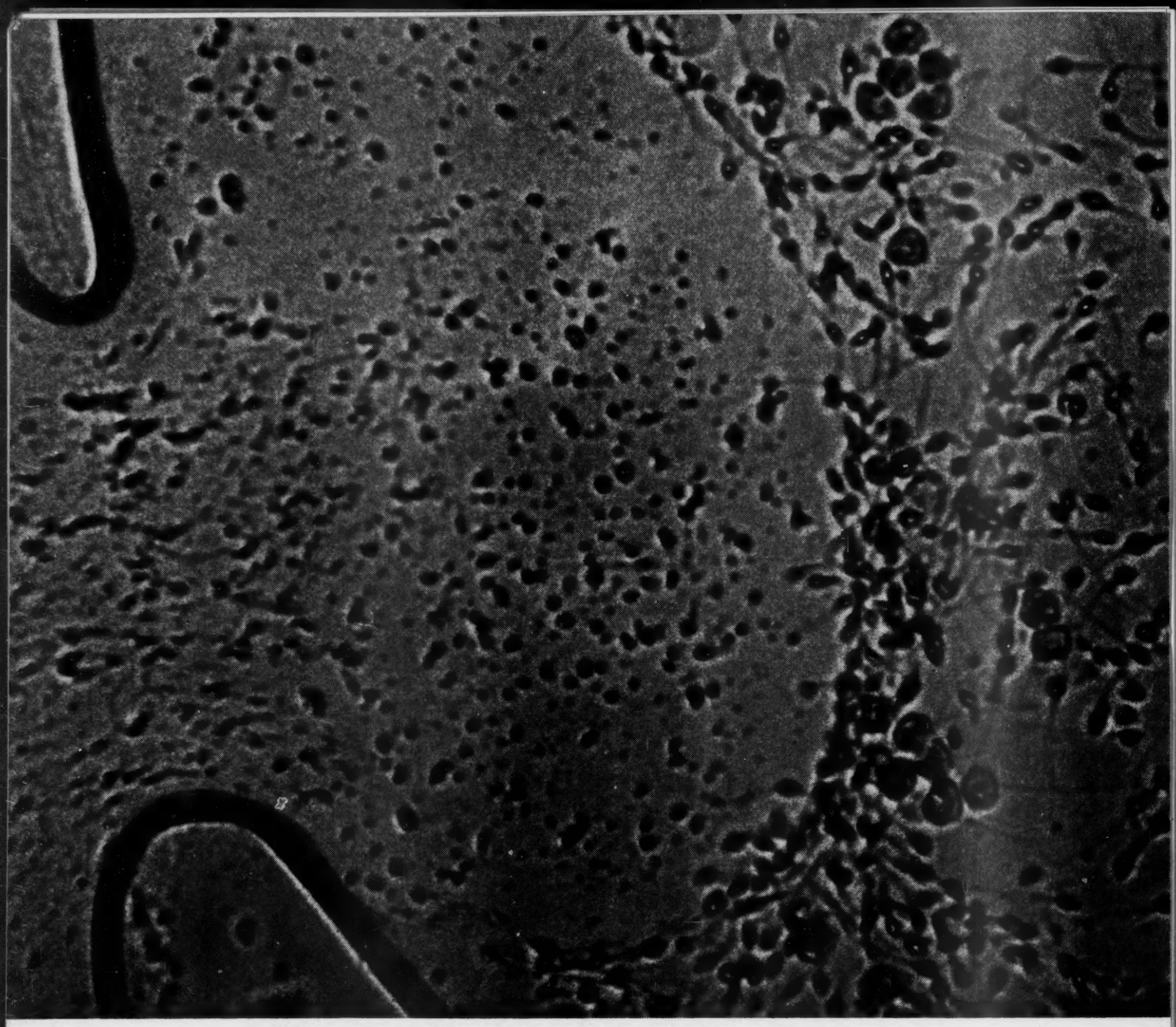

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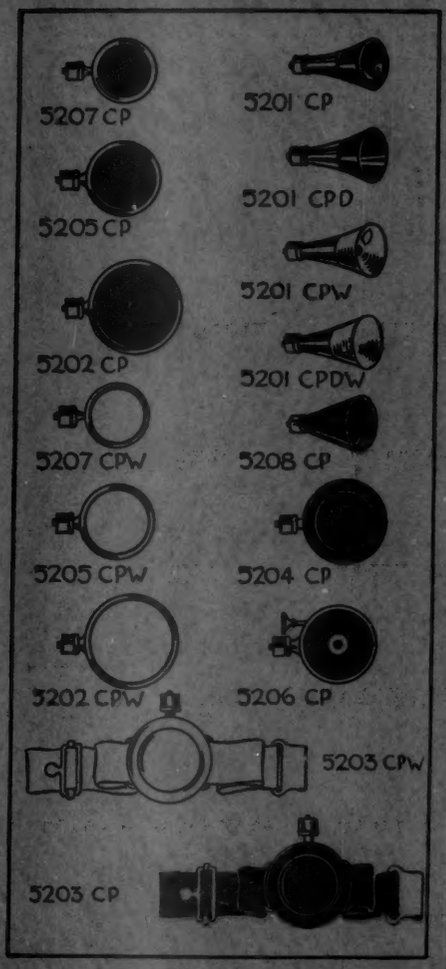

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